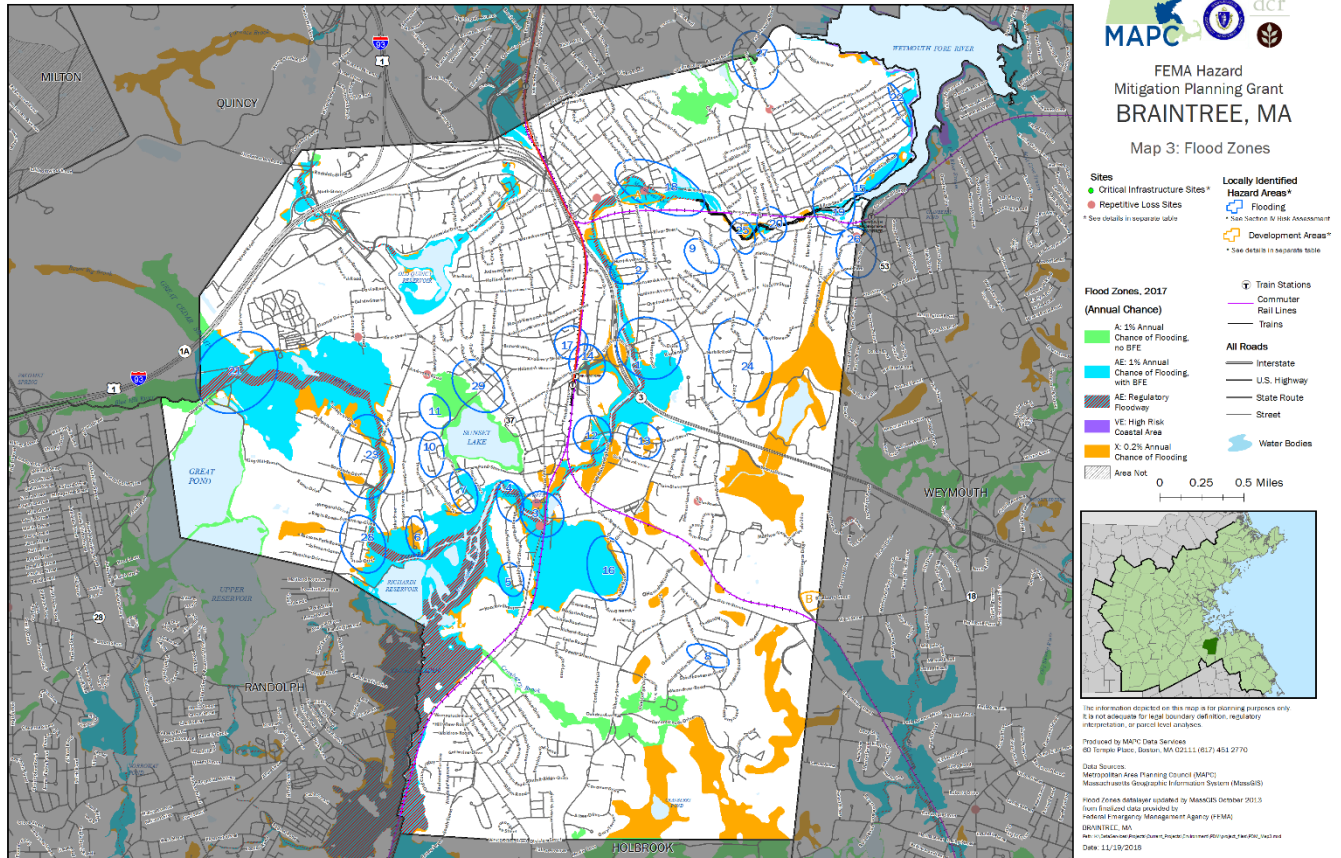


# TOWN OF BRAINTREE HAZARD MITIGATION PLAN 2019 UPDATE



**MAPC 50 YEARS**  
METROPOLITAN AREA PLANNING COUNCIL  
SMART GROWTH AND REGIONAL COLLABORATION

**Final Plan**  
**Adopted by the Town**  
**July 16, 2019**

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# ACKNOWLEDGEMENTS & CREDITS

This plan was prepared for the Town of Braintree by the Metropolitan Area Planning Council (MAPC) under the direction of the Massachusetts Emergency Management Agency (MEMA) and the Massachusetts Department of Conservation and Recreation (DCR). The plan was funded locally by the Town of Braintree.

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# SECTION 1: EXECUTIVE SUMMARY

Hazard Mitigation planning is a proactive effort to identify actions that can be taken to reduce the dangers to life and property from natural hazard events. In the communities of the Boston region of Massachusetts, hazard mitigation planning tends to focus most on flooding, the most likely natural hazard to impact these communities. The Federal Disaster Mitigation Act of 2000 requires all municipalities that wish to be eligible to receive FEMA funding for hazard mitigation grants, to adopt a local multi-hazard mitigation plan and update this plan in five year intervals.

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## PLANNING PROCESS

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Planning for the Hazard Mitigation Plan update was led by the Braintree Local Hazard Mitigation Planning Team, composed of staff from a number of different town departments, and members of the Local Emergency Planning Committee. This team met on October 25, 2018, December 5, 2018, and January 23, 2019 and discussed where the impacts of natural hazards most affect the town, goals for addressing these impacts, updates to the Town's existing mitigation measures, and new or revised hazard mitigation measures that would benefit the town.

Public participation in this planning process is important for improving awareness of the potential impacts of natural hazards and to build support for the actions the Town takes to mitigate them. The Town's Local Hazard Mitigation Planning Team hosted two public meetings, the first on January 10, 2019 and the second on April 2, 2019 and, the draft plan update was posted on the Town's website for public review. Key town stakeholders and neighboring communities were notified and invited to review the draft plan and submit comments. See Public Meetings (page 19) for comments.

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## RISK ASSESSMENT

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The Braintree Hazard Mitigation Plan assesses the potential impacts to the town from flooding, high winds, winter storms, brush fire, geologic hazards, extreme temperatures, and drought. These are shown in the map series in Appendix B.

The Braintree Local Hazard Mitigation Planning Team identified 88 Critical Facilities. These are also shown on the map series and listed in Table 32, identifying which facilities are located within the mapped hazard zones.

Hazards U.S. – Multihazards (HAZUS-MH) is a standardized methodology developed by FEMA that utilizes Geographic Information Systems (GIS) to estimate physical, economic, and social impacts of disasters. The HAZUS-MH analysis for Braintree estimates property damages from Hurricanes of category 2 and 4 (\$24 million to \$130 million), earthquakes of magnitudes 5 and 7 (\$145.6 million to \$795 million), and the 1% and .2% chance of flooding (\$20.7 to \$27 million).

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## HAZARD MITIGATION GOALS

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The Braintree Local Multiple Hazard Community Planning Team endorsed the following eleven hazard mitigation goals at the October 25, 2018 team meeting. The team added an eleventh goal focused on incorporating future climate change projections.

1. Ensure that critical infrastructure sites are protected from natural hazards.
2. Protect existing residential and business areas from flooding.
3. Maintain existing mitigation infrastructure in good condition.
4. Continue to enforce existing zoning and building regulations.
5. Educate the public about zoning and building regulations.
6. Work with surrounding communities to ensure regional cooperation and solutions for hazards affecting multiple communities.
7. Encourage future development and redevelopment in areas that are not prone to natural hazards.
8. Educate the public about natural hazards and mitigation measures.
9. Make efficient use of public funds for hazard mitigation.
10. Pursue land acquisition strategies.
11. Consider the potential impacts of future climate change. Incorporate climate sustainability and resiliency in hazard mitigation planning.

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## HAZARD MITIGATION STRATEGY

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The Braintree Local Hazard Mitigation Planning Team identified a number of mitigation measures that would serve to reduce the Town's vulnerability to natural hazard events. Overall, the hazard mitigation strategy recognizes that mitigating hazards for Braintree will be an ongoing process as our understanding of natural hazards and the steps that can be taken to mitigate their damages changes over time. Global climate change and a variety of other factors impact the Town's vulnerability in the future, and local officials will need to work together across municipal lines and with state and federal agencies in order to understand and address these changes. The Hazard Mitigation Strategy will be incorporated into the Town's other related plans and policies.

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## PLAN REVIEW & UPDATE PROCESS

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The process for developing Braintree's Hazard Mitigation Plan 2019 Update is summarized in Table 1.

**Table 1: Plan Review and Update Process**

Section	Reviews and Updates
Section 3: Public Participation	The Local Hazard Mitigation Planning Team placed an emphasis on public participation for the update of the Hazard Mitigation Plan, discussing strategies to enhance participation opportunities at the first local committee meeting. During plan development, the plan was discussed at two public meetings hosted by the Conservation Commission and Town Council. The plan was also available on the Town's website for public comment. See Public Meetings (page 19) for comments.
Section 4: Risk Assessment	MAPC gathered the most recently available hazard and land use data and met with town staff to identify changes in local hazard areas and development trends. Town staff reviewed critical infrastructure with MAPC staff in order to create an up-to-date list. MAPC also used the most recently available version of HAZUS and assessed the potential impacts of flooding using the latest data.
Section 5: Goals	The Hazard Mitigation Goals were reviewed and endorsed by the Braintree Local Hazard Mitigation Planning Team.
Section 6: Existing Mitigation Measures	The list of existing mitigation measures was updated to reflect current mitigation activities in the town.
Sections 7 and 8: Hazard Mitigation Strategy	Mitigation measures from the 2012 plan were reviewed and assessed as to whether they were completed, in progress, or deferred. The Local Hazard Mitigation Planning Team determined whether to carry forward measures into the 2019 Plan Update or modify or delete them. The Plan Update's hazard mitigation strategy reflects both new measures and measures carried forward from the 2012 plan. The Local Hazard Mitigation Team prioritized all of these measures based on current conditions.
Section 9: Plan Adoption & Maintenance	This section of the plan was updated with a new on-going plan implementation review and five year update process that will assist the Town in incorporating hazard mitigation issues into other Town planning and regulatory review processes and better prepare the Town for the next comprehensive plan update.

As indicated in Table 37, Braintree made significant progress implementing mitigation measures identified in the 2012 Hazard Mitigation Plan. Many flood protection projects have been completed. Infrastructure projects include: the drainage projects at Dickerman Lane and Staten Road, and at Bestick Road; dredging at Union Street; improvements to Great Pond Dam; a culvert replacement at West Street and; ensuring back-up or bypass for all stormwater pump stations. Other achievements include: increasing the Town's CRS rating from Class 9 to Class 7, acquiring property along the Monaquot River, daylighting a portion of Smelt Brook, purchasing two vacuum trucks, grant funding for a project to stabilize eroding shoreline on the Fore River and, completing a study of the Monaquot River.

Several projects that were not completed will be continued into this plan update. A top priority, and a significant cost, is relocation of the Public Works Highway Barn. Locations where flooding was reduced but additional work is still needed include Great Pond Dam, Union Street, and West Street. Other projects include detailed mapping of the Town's stormwater system, assessment of municipal buildings for earthquake hazards, and update of the Floodplain Zoning District.

Moving forward into the next five year plan implementation period there will be many more opportunities to incorporate hazard mitigation into the Town's decision making processes. As in the past, the Town will document any actions taken within this iteration of the Hazard Mitigation Plan on challenges met and actions successfully adopted as part of the ongoing plan maintenance to be conducted by the Braintree Hazard Mitigation Implementation Team, as described in Section 9 Plan Adoption and Maintenance.

# SECTION 2: INTRODUCTION

## PLANNING REQUIREMENTS UNDER THE FEDERAL DISASTER MITIGATION ACT

The Federal Disaster Mitigation Act, passed in 2000, requires that after November 1, 2004, all municipalities that wish to continue to be eligible to receive FEMA funding for hazard mitigation grants, must adopt a local multi-hazard mitigation plan and update this plan in five year intervals. This planning requirement does not affect disaster assistance funding.

Federal hazard mitigation planning and grant programs are administered by the Federal Emergency Management Agency (FEMA) in collaboration with the states. These programs are administered in Massachusetts by the Massachusetts Emergency Management Agency (MEMA) in partnership with the Department of Conservation and Recreation (DCR).

The Town of Braintree contracted with the Metropolitan Area Planning Council (MAPC), to assist the Town in updating its local Hazard Mitigation Plan, which was first adopted in 2005 as a multijurisdictional plan.

## WHAT IS A HAZARD MITIGATION PLAN?

Natural hazard mitigation planning is the process of determining how to systematically reduce or eliminate the loss of life and property damage resulting from natural hazards such as floods, earthquakes, and hurricanes. Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries, and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, programs, projects, and other activities.

## PREVIOUS FEDERAL/STATE DISASTERS

Since 1991, there have been 28 natural hazard events that triggered federal or state disaster declarations that included Norfolk County. These are listed in Table below. The majority of these events involved flooding, while others were due to hurricanes or nor'easters, and severe winter weather.

**Table 2: Previous Federal/State Disaster Declarations**

Disaster Name (Date of Event)	Type of Assistance	Declared Areas
Hurricane Bob (August 1991)	FEMA Public Assistance Project Grants	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Hampden, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (16 projects)
No-Name Storm (October 1991)	FEMA Public Assistance Project Grants	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk
	FEMA Individual Household Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk

<b>Disaster Name (Date of Event)</b>	<b>Type of Assistance</b>	<b>Declared Areas</b>
	Hazard Mitigation Grant Program	Counties of Barnstable, Bristol, Dukes, Essex, Middlesex, Plymouth, Nantucket, Norfolk, Suffolk (10 projects)
March Blizzard (March 1993)	FEMA Public Assistance Project Grants	All 14 Counties
January Blizzard (January 1996)	FEMA Public Assistance Project Grants	All 14 Counties
May Windstorm (May 1996)	State Public Assistance Project Grants	Counties of Plymouth, Norfolk, Bristol
October Flood (October 1996)	FEMA Public Assistance Project Grants	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
	FEMA Individual Household Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
	Hazard Mitigation Grant Program	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk (36 projects)
(1997)	Community Development Block Grant-HUD	Counties of Essex, Middlesex, Norfolk, Plymouth, Suffolk
June Flood (June 1998)	FEMA Individual Household Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
(1998)	Community Development Block Grant-HUD	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
March Flood (March 2001)	FEMA Individual Household Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Counties of Bristol, Essex, Middlesex, Norfolk, Suffolk, Plymouth, Worcester
Snowstorm (March 2001)		Berkshire, Essex, Franklin, Hampshire, Middlesex, Norfolk, Worcester
February Snowstorm (Feb 17-18, 2003)	FEMA Public Assistance Project Grants	Statewide
Snowstorm (December 2003)		Barnstable, Berkshire, Bristol, Essex, Franklin, Hampden, Hampshire, Middlesex, Norfolk, Plymouth, Suffolk, Worcester
Flooding (April 2004)		Essex, Middlesex, Norfolk, Suffolk, Worcester
January Blizzard (January 22-23, 2005)	FEMA Public Assistance Project Grants	Statewide
Hurricane Katrina (August 29, 2005)	FEMA Public Assistance Project Grants	Statewide

<b>Disaster Name (Date of Event)</b>	<b>Type of Assistance</b>	<b>Declared Areas</b>
Severe storms and flooding (October 2005)		Statewide
May Rainstorm/ Flood (May 12-23, 2006)	Hazard Mitigation Grant Program	Statewide
April Nor'easter (April 15-27, 2007)	Hazard Mitigation Grant Program	Statewide
Severe storm and flooding (December 2008)		Statewide
Flooding (March, 2010)	FEMA Public Assistance FEMA Individuals and Households Program SBA Loan	Bristol, Essex, Middlesex, Suffolk, Norfolk, Plymouth, Worcester
	Hazard Mitigation Grant Program	Statewide
Hurricane Earl (September 2010)	FEMA Public Assistance Project Grants	Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, and Worcester
Severe winter storm (January 2011)		Berkshire, Essex, Hampden, Hampshire, Norfolk, Plymouth
Tropical Storm Irene (August 27-28, 2011)	FEMA Public Assistance	Barnstable, Berkshire, Bristol, Dukes, Franklin, Hampden, Hampshire, Norfolk, Plymouth
Severe snowstorm and Flooding (February 2013)	FEMA Public Assistance; Hazard Mitigation Grant Program	Statewide
Severe storm and flooding (January 2015)		Barnstable, Bristol, Dukes, Essex, Middlesex, Nantucket, Norfolk, Plymouth, Suffolk, Worcester
Severe storm and flooding (March 2018)		Barnstable, Bristol, Essex, Nantucket, Norfolk, Plymouth
Severe winter storm (March 2018)		Essex, Middlesex, Norfolk, Suffolk, Worcester

Source: MA Hazard Mitigation and Climate Adaptation Plan, 2018

## FEMA FUNDED MITIGATION PROJECTS

Town of Braintree has received funding from FEMA for five mitigation projects under FEMA's flood mitigation programs. These projects totaled \$339,076, with \$201,932 covered by FEMA grants and \$84,769 by local funding. The projects are summarized in Table 3 below.

**Table 3: FEMA-Funded Mitigation Projects**

<b>Project Title</b>	<b>Scope of Work</b>	<b>Total Cost</b>	<b>Federal Funding</b>	<b>Local Funding</b>
Staten Road and Dickerman Lane Culvert Replacements	Culvert replacements and impoundment for stormwater management.	\$244,900	183,675	61,225
Rex Drive Drainage Project (FMA)	Installation of approximately 1,235' of 24" drain line adjacent to One Rex Drive from West Street to the adjacent wetlands.	\$284,387	\$162,414	\$71,097
FMA Plan Update (FMA)	FMA Plan update	\$10,500	\$7,875	\$2,625
Hazard Mitigation Planning (FMA)	Develop a comprehensive flood mitigation plan for the community.	\$3,640	\$2,730	\$910
Liberty Street Flood Mitigation (FMA)	Upgrading culvert at Smelt Brook under Liberty Street between Poulos Rd. and Plain St., bank improvements adjacent to the culvert	\$40,549	\$28,913	\$10,137

Source: MEMA Database

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## COMMUNITY PROFILE

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Braintree is a large suburban community situated at the crossroads of Route 128, Route 3, and I-93 about 12 miles south of Boston. Incorporated in 1640, Braintree offers easy access to the Greater Boston area and Cape Cod as well as excellent public transportation to Boston and Logan International Airport. The community has a good mix of established neighborhoods, small clusters of new homes and several condominium complexes. There is a strong business base, which includes one of the largest regional shopping malls in the northeast, the South Shore Plaza. Braintree has a rich history, including the birthplace site of two presidents, John Adams and John Quincy Adams, as well as John Hancock. Residents feel that people are attracted to Braintree as a good place to live and work because it has an excellent public school system as well as Thayer Academy and Archbishop Williams High School, and a fine parks and recreation program with the availability of many recreational resources.

The town maintains a website at <http://braintreema.gov/>

**Table 4: Braintree Characteristics**

Population = 33,828 people
<ul style="list-style-type: none"><li>• 6.2% are under age 5</li><li>• 22.4% are under age 18</li><li>• 18.1% are over age 65</li><li>• 2.4% live in group quarters</li><li>• 6.4% have a disability</li><li>• 6.7% of households are limited English-speaking</li><li>• 1.87% of households have no vehicle available</li></ul>
Number of Housing Units = 13,767
<ul style="list-style-type: none"><li>• 29.5% are renter-occupied housing units</li><li>• 29.8% of housing units were built before 1940</li></ul>

Sources:

Disability Characteristics 2005 – 2007 American Community Survey

English-speaking + vehicles: 2016 ACS 5-year estimates

1940 fact: 2017 ACS 1-year estimates

Renting info: 2016 ACS 5-year estimates

The Town of Braintree has several unique characteristics to keep in mind while planning for natural hazards:

- Braintree has been proactive in addressing flooding and climate issues. Examples of efforts include longstanding membership in FEMA’s Community Rating System, development of a Climate Vulnerability Analysis and Action Plan, adoption of a Stormwater Utility, grants for shoreline protection, and long-term commitment to tree planting.
- Braintree flood sources include riverine, coastal, stormwater and groundwater. The multiple sources are a challenge for flood management.
- Braintree has a municipal electric light department (BELD) that has a strong track record of maintaining power. BELD recently received a grant to provide battery storage of power. BELD has an ongoing tree planting initiative that provides trees to property owners.
- Braintree has multiple bridges and roads that were overtopped during flooding in 2010.

## SECTION 3: PLANNING PROCESS & PUBLIC PARTICIPATION

MAPC employs a six step planning process based on FEMA’s hazard mitigation planning guidance focusing on local needs and priorities but maintaining a regional perspective matched to the scale and nature of natural hazard events. Public participation is a central component of this process, providing critical information about the local occurrence of hazards while also serving as a means to build a base of support for hazard mitigation activities. MAPC supports participation by the general public and other plan stakeholders through two public meetings hosted by the local Hazard Mitigation Team, posting of the plan to the Town’s website, and invitations sent to neighboring communities, town boards and commissions, and other local or regional entities to review the plan and provide comment.

### PLANNING PROCESS SUMMARY

The six-step planning process outlined below is based on the guidance provided by FEMA’s Local Multi-Hazard Mitigation Planning Guidance. Public participation is a central element of this process, which attempts to focus on local problem areas and identify needed mitigation measures based on where gaps occur in the existing mitigation efforts of the municipality. By working on municipal hazard mitigation plans in groups of neighboring cities and towns, MAPC is able to identify regional opportunities for collaboration and facilitate communication between communities. In plan updates, the process described below allows staff to bring the most recent hazard information into the plan, including new hazard occurrence data, changes to a municipality’s existing mitigation measures, and progress made on actions identified in previous plans.

Figure 1: Six-Step Planning Process



1. **Map the Hazards** – MAPC relies on data from a number of different federal, state, and local sources in order to map the areas with the potential to experience natural hazards. This mapping represents a multi-hazard assessment of the municipality and is used as a set of base maps for the remainder of the planning process. A particularly important source of information is the knowledge drawn from local municipal staff on where natural hazard impacts have occurred. These maps can be found in Appendix B.
2. **Assess the Risks & Potential Damages** – Working with local staff, critical facilities, infrastructure, vulnerable populations, and other features are mapped and contrasted with the hazard data from the first step to identify those that might represent particular vulnerabilities to these hazards. Land use data and development trends are also incorporated into this analysis. In addition, MAPC develops estimates of the potential impacts of certain hazard events on the community. MAPC drew on the following resources to complete the plan:
  - Bylaws of the Town of Braintree
  - Town of Braintree, Zoning Bylaws
  - Town of Braintree Climate Vulnerability Assessment and Action Plan
  - Town of Braintree draft Open Space and Recreation Plan
  - Massachusetts State Hazard Mitigation Plan, 2013
  - FEMA, Local Mitigation Plan Review Guide, October 2011
  - FEMA, Flood Insurance Rate Maps for Norfolk County, MA, 2012
  - Massachusetts State Hazard Mitigation and Climate Adaptation Plan, 2018
  - Metropolitan Area Planning Council, GIS Lab, Regional Plans and Data.
  - New England Seismic Network, Boston College Weston Observatory, <http://aki.bc.edu/index.htm>
  - NOAA National Climatic Data Center, <http://www.ncdc.noaa.gov/>
  - Northeast States Emergency Consortium, <http://www.nesec.org/>
  - USGS, National Water Information System, <http://nwis.waterdata.usgs.gov/usa/nwis>
  - US Census, 2010 and American Community Survey 2017 5-Year Estimates
3. **Review Existing Mitigation** – Municipalities in the Boston Metropolitan Region have an active history in hazard mitigation as most have adopted flood plain zoning districts, wetlands protection programs, and other measures as well as enforcing the State building code, which has strong provisions related to hazard resistant building requirements. All current municipal mitigation measures must be documented.
4. **Develop Mitigation Strategies** – MAPC works with the local municipal staff to identify new mitigation measures, utilizing information gathered from the hazard identification, vulnerability assessments, and the community's existing mitigation efforts to determine where additional work is necessary to reduce the potential damages from hazard events. Additional information on the development of hazard mitigation strategies can be found in Section 7.
5. **Plan Approval & Adoption** – Once a final draft of the plan is complete it is sent to MEMA for the state level review and, following that, to FEMA for approval. Typically, once FEMA has approved the plan the agency issues a conditional approval (Approval Pending Adoption), with the condition being adoption of the plan by the municipality. More information on plan adoption can be found in Section 9 and documentation of plan adoption can be found in Appendix D.

6. **Implement & Update the Plan** – Implementation is the final and most important part of any planning process. Hazard Mitigation Plans must also be updated on a five year basis making preparation for the next plan update an important on-going activity. Section 9 includes more detailed information on plan implementation.

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## 2012 PLAN IMPLEMENTATION & MAINTENANCE

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The 2012 Town of Braintree Hazard Mitigation Plan contained a risk assessment of identified hazards for the town and mitigation measures to address the risk and vulnerability from these hazards. Since approval of the plan by FEMA and local adoption, progress has been made on implementation of the measures. The Town has advanced a number of projects for implementation, including numerous drainage and culvert improvements, public education, and riverfront and floodplain land preservation.

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## THE LOCAL MULTIPLE HAZARD COMMUNITY PLANNING TEAM

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MAPC worked with the local community representatives to organize a Local Hazard Mitigation Planning Team for Braintree. MAPC briefed the local representatives as to the desired composition of that team as well as the need for public participation in the local planning process. The Braintree Local Team chose to work together with Braintree's Local Emergency Planning Committee (LEPC). The participation of LEPC town staff and community members added welcome planning expertise.

The Local Hazard Mitigation Planning Team is central to the planning process as it is the primary body tasked with developing a mitigation strategy for the community. The local team was tasked with working with MAPC to set plan goals, provide information on the hazards that impact the town, existing mitigation measures, and helping to develop new mitigation measures for this plan update. The Local Hazard Mitigation Planning Team membership is listed below.

<b>Name</b>	<b>Representing</b>
Kelly Phelan	Conservation Planner, Project Manager
Amy Carey	Health Inspector, LEPC Director
Jim Arsenault	Director, Public Works
Cynthia O'Connell	Stormwater Manager
Steve Wallace	Police Officer
Robert Ferrisi	Director, Operation Braintree Rehabilitation Hospital
Suzanne Coneys	Director, Quality and Risk Mgmt. Braintree Rehabilitation Hospital
Kevin Nelligan	Captain, Fire Department
Joe Reynolds	Chief of Staff, Mayor's Office
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Dennis Girardi	Emergency Management
Bob Campbell	Town Engineer

John Mattson	Clean Harbors
David Medina	Clean Harbors
Nicole Perry	Public Health Nurse
Jay St. Ives	Police Officer
Sharmila Biswas	Director, Elder Affairs

The Braintree Planning Board and Conservation Commission are the primary entities responsible for regulating development in town. Feedback was assured through the participation of the Conservation Planner and Mayor's Chief of Staff. The newly created Stormwater Utility was represented by the Director of Public Works and the Stormwater Manager. In addition, MAPC, the State-designated regional planning authority for Braintree, works with all agencies that regulate development in the region, including the listed municipal entities and state agencies, such as the MassDOT and the MBTA.

The Local Hazard Mitigation Planning Team met on the following dates: October 25, 2018; December 5, 2018; and January 23, 2019. The purpose of the meetings was to introduce the Hazard Mitigation planning program, review and update hazard mitigation goals, and to gather information on local hazard mitigation issues and sites or areas related to these. Later meetings focused on verifying information gathered by MAPC staff and discussion of existing mitigation practices, the status of mitigation measures identified in the 2012 hazard mitigation plan, and potential new or revised mitigation measures. The agendas for these meetings are included in Appendix A.

## PUBLIC MEETINGS

Public participation in the hazard mitigation planning process is important, both for plan development and for later implementation of the plan. Residents, business owners, and other community members are an excellent source for information on the historic and potential impacts of natural hazard events and particular vulnerabilities the community may face from these hazards. Their participation in this planning process also builds understanding of the concept of hazard mitigation, potentially creating support for mitigation actions taken in the future to implement the plan. To gather this information and educate residents on hazard mitigation, the Town hosted two public meetings, one during the planning process and one after a complete draft plan was available for review.

Natural hazard mitigation plans unfortunately rarely attract much public involvement in the Boston region, unless there has been a recent hazard event. One of the best strategies for overcoming this challenge is to include discussion of the hazard mitigation plan on the agenda of an existing board or commission. With this strategy, the meeting receives widespread advertising and a guaranteed audience of the board or commission members plus those members of the public who attend the meeting. These board and commission members represent an engaged audience that is informed and up to date on many of the issues that relate to hazard mitigation planning in the locality and will likely be involved in plan implementation, making them an important audience with which to build support for hazard mitigation measures. In addition, these meetings frequently receive press coverage, expanding the audience that has the opportunity to hear the presentation and provide comment.

The public had an opportunity to provide input to the Braintree hazard mitigation planning process during a meeting of the Conservation Commission held on January 10, 2019 at Braintree Town Hall. The draft

plan update was presented at a Town Council meeting on April 2, 2019 at Braintree Town Hall. The Town Council meeting was broadcast on local cable television. Both meetings were publicized in accordance with the Massachusetts Public Meeting Law. The attendance list for each meeting can be found in Table 5. See public meeting notices in Appendix C.

At the January 10, 2019 meeting comments included: 1) wind damage is an important issue that needs to be addressed; 2) communication and public education are important, people need warning and a safe place to go, and people should be informed about protective actions they can take; 3) loss of electricity and ice storms are key concerns; 4) Edgehill Road should be noted as a flooding area, flooding has occurred three times in the past year, much more frequent than in the past; 5) the dam in the Town Forest on Cranberry Brook should be investigated as a potential hazard; 6) undersized culverts are an important flooding issue; 7) many issues are regional not just local, the scope needs to be expanded; 8) there is a tension between private property rights and the need to remove properties from harm, how do we address that; 9) climate change is an important consideration, updating of bylaws including local wetlands bylaw is needed to address changing conditions; 10) the town has strong emergency planning in place. After the April 2 meeting comments included: correction on dam names and concern for the status of Cranberry Pond Dam. The comments are addressed throughout the document.

<b>Table 5</b>	
<b>Braintree Public Meetings</b>	
<b>Meeting #1 January 10, 2019</b>	
<b>Total Attendance: 12</b>	
<b>Name</b>	<b>Representing</b>
Kelly Phelan	Conservation Planner
7 members of the Conservation Commission and 4 members of the public.	
<b>Meeting #2 April 2, 2019</b>	
<b>Total Attendance: 21</b>	
<b>Name</b>	<b>Representing</b>
Kelly Phelan	Conservation Planner
Christine Stickney	Director of Planning and Community Development
Joseph Reynolds	Chief of Staff
8 members of Town Council and 10 member of the public	

## LOCAL STAKEHOLDER INVOLVEMENT

The local Hazard Mitigation Planning Team was encouraged to reach out to local stakeholders that might have an interest in the Hazard Mitigation Plan including neighboring communities, agencies, businesses, nonprofits, and other interested parties. Notice was sent to the following organizations and neighboring municipalities inviting them to review the Hazard Mitigation Plan and submit comments to the Town:

- Sustainable Braintree
- Fore River Watershed
- South Shore Chamber of Commerce
- East Braintree Civic Association
- North Braintree Civic Association
- City of Quincy
- Town of Weymouth
- Town of Holbrook
- Town of Randolph

See Appendix C for public meeting notices. The draft Braintree Hazard Mitigation Plan 2019 Update was posted on the Town's website for the second public meeting. Members of the public could access the draft document and submit comments or questions to the Town. See public comments on page 19.

## **CONTINUING PUBLIC PARTICIPATION**

Following the adoption of the plan update, the planning team will continue to provide residents, businesses, and other stakeholders the opportunity to learn about the hazard mitigation planning process and to contribute information that will update the town's understanding of local hazards. As updates and a review of the plan are conducted by the Hazard Mitigation Implementation Team, these will be placed on the Town's web site, and any meetings of the Hazard Mitigation Implementation Team will be publicly noticed in accordance with town and state open meeting laws.

## **PLANNING TIMELINE**

October 25, 2018	Meeting of the Braintree Local Hazard Mitigation Planning Team
December 5, 2018	Meeting of the Braintree Local Hazard Mitigation Planning Team
January 10, 2019	First Public Meeting with the Braintree Conservation Commission
January 23, 2019	Meeting of the Braintree Local Hazard Mitigation Planning Team
April 2, 2019	Second Public Meeting with the Braintree Town Council
April 21, 2019	Draft Plan Update submitted to MEMA
May 17, 2019	Revised Draft Plan submitted to MEMA
June 4, 2019	Revised Draft Plan submitted to FEMA
June 4, 2019	FEMA issued notice of Approvable Pending Adoption
July 16, 2019	Final Plan Adopted by the Town of Braintree
TBD	FEMA issued formal letter of plan approval

## **POST-APPROVAL IMPLEMENTATION AND PLAN UPDATE TIMELINE**

Annually, 2020-23	Convene Hazard Mitigation Team and conduct Annual Review of progress
Fall 2021-Spring 2022	Seek FEMA grant for next plan update if/when available from MEMA
January 2023	Begin process to prepare next update of the plan
January 2024	Submit Draft 2024 Plan Update to MEMA and FEMA
July 2024	FEMA approval of 2024 Plan Update

## SECTION 4: RISK ASSESSMENT

The risk assessment analyzes the potential natural hazards that could occur within the Town of Braintree as well as the relationship between those hazards and current land uses, potential future development, and critical infrastructure. Climate change is projected to have significant impacts on many natural hazards. The Town of Braintree completed a Climate Vulnerability Assessment Plan in 2017. Information from the 2012 Hazard Mitigation plan was incorporated in the 2017 plan. Both risk assessment and potential mitigation identified in the 2017 plan are incorporated in this updated Hazard Mitigation Plan. This section also includes a vulnerability assessment that estimates the potential damages that could result from certain large scale natural hazard events.

In order to update Braintree's risk assessment, MAPC gathered the most recently available hazard and land use data and met with Town staff to identify changes in local hazard areas and development trends. MAPC also used FEMA's damage estimation software, HAZUS.

### OVERVIEW OF HAZARDS AND IMPACTS

The Massachusetts Hazard Mitigation Plan provides an in-depth overview of natural hazards in Massachusetts. Previous state and federal disaster declarations since 1991 are summarized in Table 2. Table 6 below summarizes the hazard risks for Braintree. This evaluation takes into account the frequency of the hazard, historical records, and variations in land use. This analysis is based on the vulnerability assessment in the Massachusetts State Hazard Mitigation Plan 2013. The statewide assessment was modified to reflect local conditions in Braintree using the definitions for hazard frequency and severity listed below. Based on this, the Town set an overall priority for each hazard.

**Table 6: Hazard Risks Summary**

Hazard	Frequency		Severity	
	Massachusetts	Braintree	Massachusetts	Braintree
Flooding	High	High	Serious to extensive	Serious
Dam failures	Low	Low	Extensive	Extensive
Coastal Hazards	High	Medium	Serious	Minor
Hurricane/Tropical Storm	Medium	Medium	Serious	Serious
Tornadoes	Medium	Low	Serious	Minor
Thunderstorms	High	High	Minor	Minor
Nor'easter	High	High	Minor	Minor
Winter-Blizzard/Snow	High	High	Minor	Minor
Winter-Ice Storms	Medium	Medium	Minor	Minor
Earthquakes	Very Low	Very Low	Serious	Serious
Landslides	Low	Low	Minor	Minor
Brush fires	Medium	Medium	Minor	Minor
Extreme Temperatures	Medium	Medium	Minor	Minor
Drought	Low	Low	Minor	Minor

Source: Massachusetts State Hazard Mitigation Plan, 2013, modified for Braintree

## Definitions Used in the Commonwealth of Massachusetts State Hazard Mitigation Plan 2013

### Frequency

- **Very low frequency:** events that occur less frequently than once in 100 years (less than 1% per year).
- **Low frequency:** events that occur from once in 50 years to once in 100 years (1% to 2% per year).
- **Medium frequency:** events that occur from once in 5 years to once in 50 years (2% to 20% per year).
- **High frequency:** events that occur more frequently than once in 5 years (Greater than 20% per year).

### Severity

- **Minor:** Limited and scattered property damage; limited damage to public infrastructure and essential services not interrupted; limited injuries or fatalities.
- **Serious:** Scattered major property damage; some minor infrastructure damage; essential services are briefly interrupted; some injuries and/or fatalities.
- **Extensive:** Widespread major property damage; major public infrastructure damage (up to several days for repairs); essential services are interrupted from several hours to several days; many injuries and/or fatalities.
- **Catastrophic:** Property and public infrastructure destroyed; essential services stopped; numerous injuries and fatalities.

## FLOOD-RELATED HAZARDS

Flooding was the most prevalent serious natural hazard identified by local officials in Braintree. Flooding is generally caused by hurricanes, nor'easters, severe rainstorms, and thunderstorms. Global climate change has the potential to exacerbate these issues over time with the potential for changing rainfall patterns leading to heavier storms, and sea level rise exacerbating coastal flooding.

### **REGIONALLY SIGNIFICANT FLOODS**

There have been a number of major floods that have affected the Metro Boston region over the last fifty years. Significant flood events that have impacted Braintree include:

- The Blizzard of 1978
- January 1979
- April 1987
- October 1991
- October 1996
- June 1998
- March 2001
- April 2004
- May 2006
- April 2007
- March 2010
- January 2015

Local data for previous flooding occurrences are not collected by the Town of Braintree. The best available local data is for Norfolk County through the National Climatic Data Center. Norfolk County, which includes the Town of Braintree, experienced 51 flood events from 1996 to 2016 (see Table 7). No

deaths or injuries were reported and the total reported property damage in the county was \$26.2 million dollars. Of that total, \$24.9 million is attributed to the two major events of March 2010.

**Table 7: Norfolk County Flood Events, 1996 to 2018**

Date	Deaths	Injuries	Property Damage
01/27/1996	0	0	0.00K
09/18/1996	0	0	0.00K
10/21/1996	0	0	0.00K
05/12/1998	0	0	0.00K
06/13/1998	0	0	570.00K
06/15/1998	0	0	0.00K
03/05/2001	0	0	0.00K
03/22/2001	0	0	0.00K
03/22/2001	0	0	0.00K
04/01/2001	0	0	0.00K
03/28/2005	0	0	0.00K
10/15/2005	0	0	30.00K
10/15/2005	0	0	40.00K
10/15/2005	0	0	200.00K
10/15/2005	0	0	60.00K
10/15/2005	0	0	40.00K
10/15/2005	0	0	140.00K
10/25/2005	0	0	35.00K
05/13/2006	0	0	5.00K
06/07/2006	0	0	20.00K
06/07/2006	0	0	0.00K
06/07/2006	0	0	0.00K
10/28/2006	0	0	8.00K
11/24/2006	0	0	0.00K
03/02/2007	0	0	5.00K
04/18/2007	0	0	5.00K
02/13/2009	0	0	10.00K
07/02/2009	0	0	5.00K
08/15/2009	0	0	3.00K
05/24/2009	0	0	0.00K
06/27/2009	0	0	15.00K
03/14/2010	0	0	16.64M
03/29/2010	0	0	8.320M
04/01/2010	0	0	0.00K
07/24/2010	0	0	20.00K
08/05/2010	0	0	0.00K
08/25/2010	0	0	8.00K

Date	Deaths	Injuries	Property Damage
08/28/2011	0	0	0.00K
08/15/2012	0	0	0.00K
10/29/2012	0	0	0.00K
06/07/2013	0	0	0.00K
07/29/2013	0	0	0.00K
08/09/2013	0	0	15.00K
10/22/2014	0	0	0.00K
10/23/2014	0	0	0.00K
8/15/2015	0	0	0.00K
8/18/2015	0	0	0.00K
8/18/2015	0	0	0.00K
6/07/2016	0	0	0.00K
6/07/2016	0	0	5.00K
8/14/2016	0	0	5.00K
4/1/2017	0	0	5.00K
7/12/2017	0	0	0.00K
7/18/2017	0	0	1.00K
8/2/2017	0	0	0.00K
9/30/2017	0	0	10.00K
10/25/2017	0	0	0.00K
10/29/2017	0	0	0.00K
01/12/2018	0	0	0.00K
01/13/2018	0	0	0.00K
04/16/2018	0	0	0.00K
<b>Total</b>	<b>0</b>	<b>0</b>	<b>26.2 M</b>

Source: NOAA, National Climatic Data Center

## OVERVIEW OF TOWN-WIDE FLOODING

The Town of Braintree is subject to two kinds of flooding; coastal flooding where wind and tide leads to flooding along tidal waterways and inland flooding where the rate of precipitation or amount of draining water overwhelms the capacity of natural and structured drainage systems to convey water causing it to overflow the system. These two types of flooding are often combined as draining stormwater is blocked by the inland push of wind and tide driven water. Both types of flooding can be caused by major rain storms, including nor'easters and hurricanes as well as snow melt.

### Inland/Riverine Flooding

The inland waterways of Braintree include the Monaquot River and its tributaries and much of the inland flooding in the Town is associated with this watershed. The watershed is largely urbanized and heavy rains and snowfall events lead to overflowing streambanks and stormwater control structures (see locally identified areas of flooding below). Debris in the waterways appears to contribute to this problem. Impervious surfaces associated with development serve to exacerbate flooding as they prevent storm water from infiltrating into the ground thereby increasing the volume of water runoff that flowing into the system and contributing to flooding.

### Coastal Flooding

Coastal flooding is associated with severe coastal storms that, through the combination of winds and tides, drive tidal waters to higher levels than normally experienced, leading to the inundation of low lying land areas and the overtopping of sea walls. Braintree has limited exposure to coastal flooding and flooding is relatively infrequent in the tidal portion of its waterfront in the East Braintree area. However, as sea level rises, Braintree is seeing an increase in impacts along the tidal shoreline. An additional issue is when the presence of a high tide limits the ability of stormwater to drain from inland waterways.

## CLIMATE CHANGE AND FLOODING

Our warming climate is projected to increase inland flooding due to more frequent and extreme rain events, and coastal flooding due to rising sea level and more frequent and intense storms.

### Inland Flooding

Annual precipitation in Massachusetts increased by approximately 10% in the fifty-year period from 1960 to 2010 (MA Climate Change Adaptation Report 2011). Moreover, for the Northeast US, according to the U.S. National Climate Assessment, 2014, there was a 71% increase in the amount of rain that falls in the top 1% of storm events for the period 1958-2012. Precipitation frequency estimates, which are used to derive stormwater design standards, were published in 1961 by the U.S. Commerce Department in a document known as TP-40 (Technical Paper 40). The National Oceanic and Atmospheric Administration (NOAA Atlas 14) and the Northeast Regional Climate Center (NRCC) at Cornell University have recently published updated estimates. The City of Cambridge developed projections for future storms. The past and projected increase in the size of the 10-year, 24-hour storm are shown in Table 8 below.

**Table 8. Design Storm Estimates**

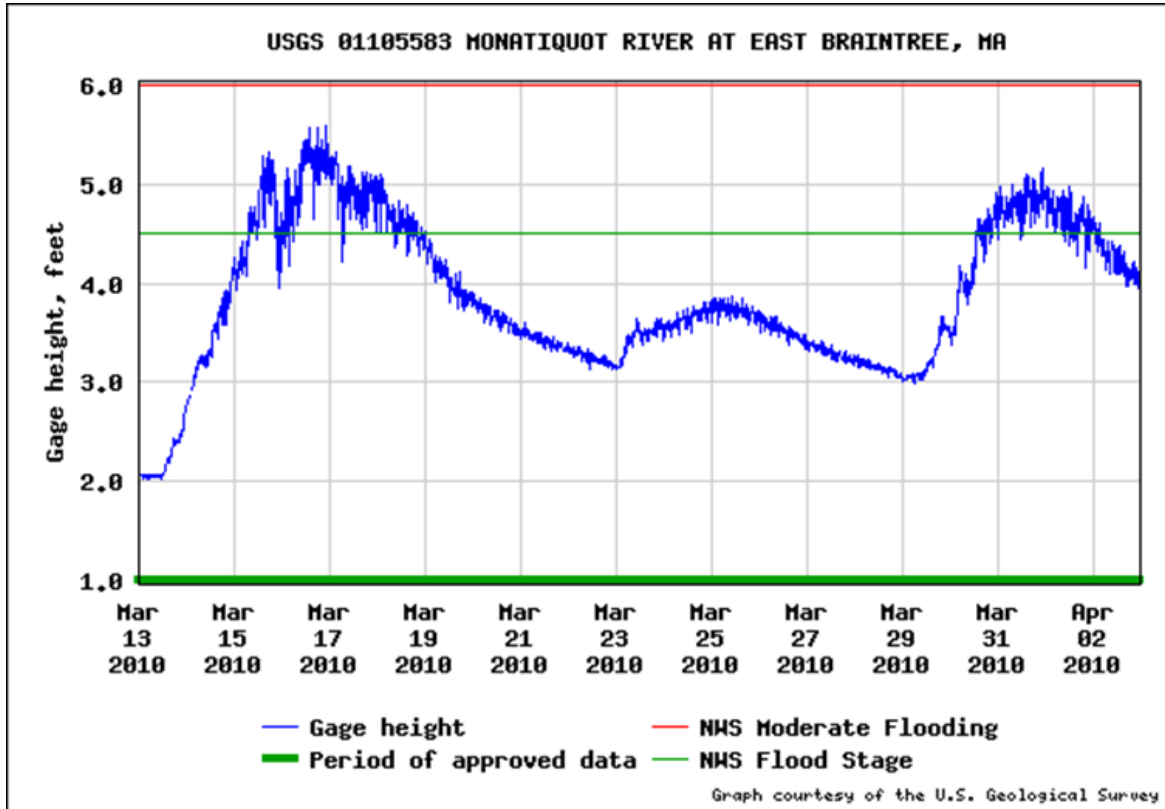
<b>Braintree</b>	<b>TP-40 1961</b>	<b>NOAA Atlas 14 Current</b>	<b>NRCC Current</b>	<b>Cambridge Projected 2015-2044</b>	<b>Cambridge Projected 2055-2084</b>
10-year, 24-hour storm	4.5"	5.24"	4.91"	5.6"	6.4"

The rainstorms of March 2010, which caused significant flooding in Braintree are an example of the type of event predicted to happen more frequently. As shown in Figure 2 below, The Monaquot River exceeded flood stage twice. Flooding was widespread throughout Braintree including overtopping six bridges, street flooding, DPW flooding, and FEMA reimbursed flood claims for more than 600 properties.

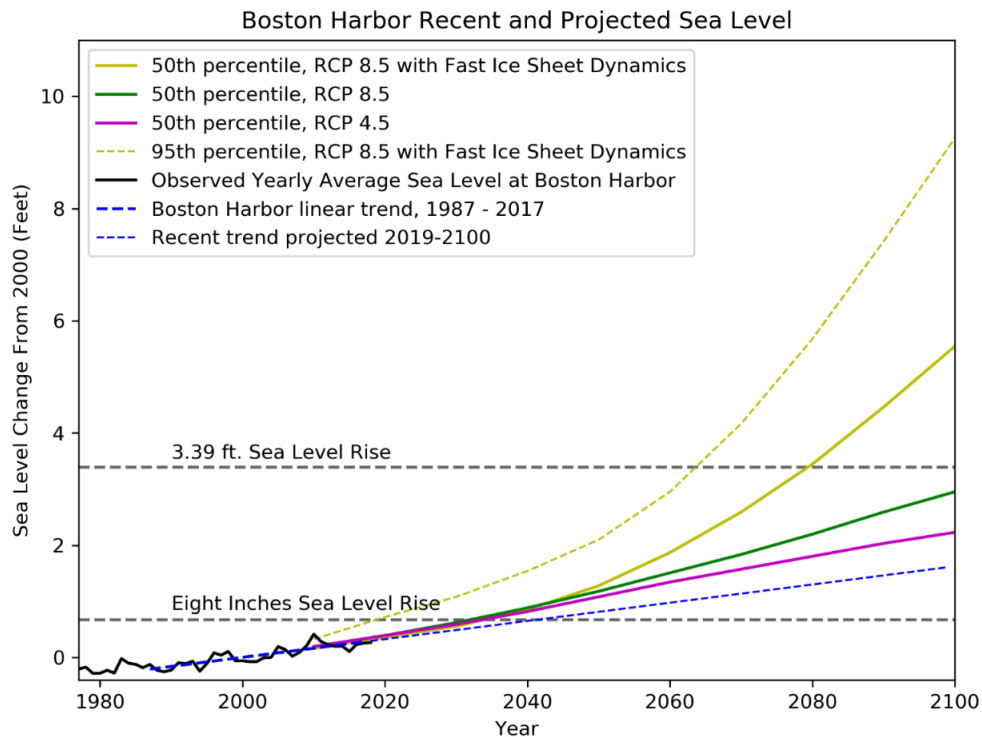
### Coastal Flooding

Records from the Boston Tide Station show that sea level has risen nearly a foot in the last century. Projections for future sea level rise range considerably, depending on future greenhouse gas emissions and the rate of melting ice sheets (see Figure 3 below). In January 2016, a coastal storm caused the highest surge since 1978. Flooding occurred along the Fore River including Watson Park and Edgehill Road. Flooding along the Monaquot River extended up to Shaw Street.

**Figure 2. March 2010 USGS Monaquot River Gage**



**Figure 3. Boston Harbor Recent and Projected Sea Level Rise**



Source: Northeast Climate Adaptation Science Center and MAPC

## POTENTIAL FLOOD HAZARD AREAS

Information on potential flood hazard areas was taken from two sources. The first was the National Flood Insurance Rate Maps. The FIRM flood zones are shown on Map 3 in Appendix B and their definitions are listed below.

### Flood Insurance Rate Map Zone Definitions

**Zone A** (1% annual chance): Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs (base flood elevations) or depths are shown within this zone. Mandatory flood insurance purchase requirements apply.

**Zone AE** (1% annual chance): Zones AE and A1-A30 are the flood insurance rate zones that correspond to the 100-year floodplains that are determined in the FIS by detailed methods. In most instances, BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.

**Zone VE** (1% annual chance): Zone VE is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.

## OTHER LOCALLY IDENTIFIED AREAS OF FLOODING

In addition, information on areas subject to flooding was provided by local officials. The “Locally Identified Areas of Flooding” described below were identified by Town staff as areas where flooding is known to occur. These areas do not necessarily coincide with the flood zones from the FIRM maps. Some may be areas that flood due to inadequate drainage systems, high groundwater, or other local conditions rather than a location within a flood zone. The numbers correspond to the numbers on Map 8, “Local Hazard Areas.”

**Table 9: Other Locally Identified Areas of Flooding**

Map ID	Name	Description
1	Braintree Highway Barn	The Union Street pump station and neighboring homes receive overflow from the Monaquot River.
2	Harding Avenue	Overflow from the Monaquot River floods homes in this area.
3	Hancock Street & Route 37	Overflow from the Monaquot River floods homes in this area.
4	Jefferson Street at Shepherd Street	Overflow from the Monaquot River floods homes in this area.
5	Jefferson Street at Ellery Street	Overflow from the Monaquot River floods homes in this area.
6	Solar Avenue	Overflow from the Monaquot River floods homes in this area.

7	Wayne Avenue	Overflow from a tributary to the Monatiquot River floods homes in this area.
8	Winter Street	Groundwater sourced flooding occurs here.
9	Hillside Road	Runoff from South Middle School and a high groundwater table causes flooding here.
10	Glendale Road	Groundwater sourced flooding occurs here.
11	Braintree High School	The athletic fields flood. The fields are filled former wetlands.
12	Pearl Street near the Monatiquot River	Overflow from the Monatiquot River floods this area.
13	Crawford and Webb Streets and Stevens Avenue	Overflow from the Monatiquot River floods this area.
14	Union Street	This area can be prone to “flash flooding” as a large area of paved surface drains to this area. Overflow from the river also contributes to flooding at the rotary. Flooding can be two feet deep but dissipates quickly.
15	Watson Park	This area is subject to flooding from coastal storm surge.
16	Alida Road/Cedar Swamp	Flooding from the swamp reaches the adjacent homes.
17	Woodsum Drive	This is groundwater sources flooding. Short-term flash street flooding occurs here.
18	Adams Street	From Elm to Commercial Streets is subject to flooding due to downstream constriction in the Monatiquot River floodplain.
19	Allen Street	Flooding occurs when the Monatiquot River overflows its banks. Sewage overflows are also an issue in this location.
20	Commercial Street	Flooding from the Monatiquot River happens downstream from the bridge.
21	West Street/Great Pond Dam	Road flood happens here. A culvert replacement project has reduced the flooding.
22	Vinedale and Edgehill Roads	Flooding here is a result of coastal storm surge.
23	Lundquist and Campanelli Drives and Granite Street	Overflow from the Farm River causes flooding here.
24	Andrea and Eileen Drives, and Norfolk Road	Groundwater sourced flooding occurs here.
25	Trotter Green	This area is at very low elevation. Groundwater infiltrating the sewer system leads to flooding during large storms.
26	Commercial Street and Brookside Road	Flooding comes from Pond Meadow Park and floods the pump station area. There have been some drainage improvements related to the Greenbush MBTA project.
27	Quincy Avenue and	The sewer pump station is subject to flooding.

	Brookside Road	
28	Barstow Drive near Ida Road	The Farm River pump station area floods.
29	Franklin Street between Lakeview and Hollingsworth Avenues	Drainage is in need of repair here. State and town roads are both involved.

### REPETITIVE LOSS STRUCTURES

As defined by the Community Rating System (CRS) of the National Flood Insurance Program (NFIP), a repetitive loss property is any property which the NFIP has paid two or more flood claims of \$1,000 or more in any given 10-year period since 1978. There are 19 repetitive loss properties in Braintree including 14 residential and five commercial properties. These properties are shown on the maps in Appendix A. These repetitive loss properties had a total of 55 losses between 1998 and 2017, totaling \$1,376,844 in damages. For more information on repetitive losses see [https://www.fema.gov/txt/rebuild/repetitive\\_loss\\_faqs.txt](https://www.fema.gov/txt/rebuild/repetitive_loss_faqs.txt) and <https://www.fema.gov/repetitive-flood-claims-grant-program-fact-sheet>.

Table 10 summarizes the number and type of repetitive loss structures located within Braintree and the number of losses and total claims associated with them.

**Table 10 Summary of Repetitive Losses and Claims**

	Single Family Residential	Multi Family Residential	Commercial	Total
<b>Number of Properties</b>	11	3	5	19
<b>Number of Losses</b>	28	8	19	55
<b>Total Claims</b>	\$235,921	\$920,014	\$220,909	\$1,376,444

Source: Department of Conservation and Recreation, FEMA Repetitive Loss data

The 2013 state plan indicates that Massachusetts is one of 10 states that cumulatively account for 76% of all repetitive loss buildings in the United States. Based on the record of previous occurrences flooding events in Braintree are a high frequency event as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in five years, or a greater than 20% chance per year.

### DAMS AND DAM FAILURE

Dam failure can arise from two types of situations. Dams can fail because of structural problems or age, independent of any storm event. Dam failure can follow an earthquake by causing structural damage. Dams can fail structurally because of flooding arising from a storm or they can overspill due to flooding.

In the event of a dam failure, the energy of the water stored behind even a small dam can cause loss of life and property damage if there are people or buildings downstream. The number of fatalities from a

dam failure depends on the amount of warning provided to the population and the number of people in the area in the path of the dam's floodwaters. An issue for dams in Massachusetts is that many were built in the 19<sup>th</sup> century without the benefits of modern engineering or construction oversight. In addition, some dams have not been properly maintained.

Dam failure is a highly infrequent occurrence but a severe incident could result in loss of lives and significant property damage. According to the Association of State Dam Safety Officials, three dams have failed in Massachusetts since 1984, one of which resulted in a death. There have been no recorded dam breaches in Braintree.

*Quincy Reservoir Dam (also known as the Braintree Dam)* – The dam is owned by the Massachusetts Department of Conservation and Recreation (DCR) previously known as the MDC. The dam is located off Lakeside Drive and if this dam broke, there would be substantial property damage but it is unlikely that there would be any loss of life. It is listed by DCR as a high hazard dam.

*Eaton's Pond Dam* – This pond and its dam are owned by the Braintree Conservation Commission and Peabody Properties. The pond drains into a stream that has the capacity to handle the waters in the event of a dam failure. Eaton's Pond is a non-jurisdictional dam (not inspected by DCR).

*Armstrong Dam* – This pond and its dam are owned by the F.X. Messina Corporation. The pond is a mill pond that was created to allow the water usage by the adjacent retired factory. The pond drains into the Monaquot River which has the capacity to handle the waters in the event of a dam failure. The Town of Braintree is working on a project that will remove the dam as part of a program to restore fish passage. It is listed by DCR as a high hazard dam.

*Factory Pond Dam* – is located just downstream of Armstrong Dam. It is listed by DCR as a non-jurisdictional dam.

*Pond Meadow Park Dam* – This pond and its dam are owned by the Braintree Weymouth Conservation District. The pond drains into a stream that has the capacity to handle the waters in the event of a dam failure. It is listed by DCR as a high hazard dam.

*Great Pond Dam* – As noted elsewhere in this plan, the Tri-Town Board of Water Commissioners made improvements to the dam, and plans additional work to complete repairs. It is listed by DCR as a high hazard dam.

*Cranberry Brook Dam* – Is a non-jurisdictional dam (not inspected by DCR). Town staff and public comments indicate the dam is in poor condition and should be considered for removal.

#### DCR Dam Hazard Classification

**High:** Dams located where failure or mis-operation will likely cause loss of life and serious damage to homes(s), industrial or commercial facilities, important public utilities, main highways(s) or railroad(s).

**Significant:** Dams located where failure or mis-operation may cause loss of life and damage home(s), industrial or commercial facilities, secondary highway(s) or railroad(s)

**Low:** Dams located where failure or mis-operation may cause minimal property damage to others. Loss of life is not expected.

Based on the record of previous occurrences, dam failure in Braintree is a very low frequency event as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur less frequently

than once in 50 years to once in 100 years (1% to 2% per year). There have been no dam failures in Braintree to date.

### **CLIMATE CHANGE AND DAMS**

The increasing intensity of precipitation is the primary climate concern for dams, as they were most likely designed based on historic weather patterns. The State Hazard Mitigation and Climate Adaptation Plan (SHMCAP) indicates that changing precipitation patterns may increase the likelihood of overflow events.

### **ICE JAMS**

Ice jams occur in cold weather when normally flowing water begins to freeze effectively damming the waterway and causing localized flooding in the area. There are no records of ice jams in Braintree in the Army Corps of Engineers Ice Jam Database. There is no recent history of ice jams leading to flooding in Braintree and Town staff did not identify this hazard as an issue for the Town.

## **WIND-RELATED HAZARDS**

Wind-related hazards include hurricanes, tropical storms, and tornadoes, as well as high winds during nor'easters and thunderstorms. As with many communities, falling trees that result in downed power lines and power outages are an issue in Braintree. Information on wind related hazards can be found on Map 5 in Appendix B.

### **HURRICANES AND TROPICAL STORMS**

A hurricane is a violent wind and rainstorm with wind speeds of 74 to 200 miles per hour. A hurricane is strongest as it travels over the ocean and is particularly destructive to coastal property as the storm hits land. Given its location not too distant from the coast, the Town of Braintree's entire area is vulnerable to hurricanes, which occur between June and November. A tropical storm has similar characteristics, but wind speeds are below 74 miles per hour. Since 1900, 39 tropical storms have impacted New England (NESEC). Massachusetts has experienced approximately 32 tropical storms, nine Category 1 hurricanes, five Category 2 hurricanes and one Category 3 hurricane.

As shown in the hazard mapping in Appendix B, one tropical depression tracked through Braintree in 1876 and one tropical storm tracked through Braintree in 1888. A hurricane or storm track is the line that delineates the path of the eye of a hurricane or tropical storm. The town also experiences the impacts of the wind and rain from hurricanes and tropical storms regardless of whether the storm track passed through the town. The hazard mapping indicates that the 100 year wind speed in Braintree is 110 miles per hour.

**Table 11: Hurricane Records for Massachusetts, 1938 to 2018**

<b>Hurricane Event</b>	<b>Date</b>
Great New England Hurricane*	September 21, 1938
Great Atlantic Hurricane*	September 14-15, 1944
Hurricane Doug	September 11-12, 1950
Hurricane Carol*	August 31, 1954
Hurricane Edna*	September 11, 1954
Hurricane Diane	August 17-19, 1955

<b>Hurricane Event</b>	<b>Date</b>
Hurricane Donna	September 12, 1960
Hurricane Gloria	September 27, 1985
Hurricane Bob	August 19, 1991
Hurricane Earl	September 4, 2010
Tropical Storm Irene	August 28, 2011
Hurricane Sandy	October 29-30, 2012

\*Category 3

Source: National Oceanic and Atmospheric Administration

Hurricane intensity is measured according to the Saffir/Simpson scale, which categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge potential. These are combined to estimate potential damage. The following gives an overview of the wind speeds, surges, and range of damage caused by different hurricane categories:

**Table 12: Saffir/Simpson Scale**

<b>Scale No. (Category)</b>	<b>Winds (mph)</b>	<b>Surge (ft)</b>	<b>Potential Damage</b>
1	74 – 95	4 - 5	Minimal
2	96 – 110	6 - 8	Moderate
3	111 – 130	9 - 12	Extensive
4	131 – 155	13 - 18	Extreme
5	> 155	>18	Catastrophic

Source: NOAA

Hurricanes typically have regional impacts beyond their immediate tracks. Falling trees and branches are a significant problem because they can result in power outages when they fall on power lines or block traffic and emergency routes. Hurricanes are a town-wide hazard in Braintree. Potential hurricane damages to Braintree have been estimated using HAZUS-MH. Total damages are estimated at \$24 million for a Category 2 hurricane and \$130 million for a Category 4 hurricane. Other potential impacts are detailed in Table 33.

Based on records of previous occurrences, hurricanes in Braintree are a medium frequency event as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard occurs from once in 5 years to once in 50 years, or a 2% to 20% chance per year.

### **CLIMATE CHANGE AND HURRICANES**

Climate models suggest that hurricanes will become more intense as warmer ocean waters provide more fuel for the storms. In addition, rainfall amounts associated with hurricanes are predicted to increase because warmer air can hold more water vapor.

### **TORNADOS**

A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud. These events are spawned by thunderstorms and occasionally by hurricanes, and may occur singularly or in multiples. They develop when cool air overrides a layer of warm air, causing the warm air to rise rapidly. Most vortices remain suspended in the atmosphere. Should they touch down, they become a force of destruction. Some ingredients for tornado formation include:

- Very strong winds in the mid and upper levels of the atmosphere
- Clockwise turning of the wind with height (from southeast at the surface to west aloft)
- Increasing wind speed with altitude in the lowest 10,000 feet of the atmosphere (i.e., 20 mph at the surface and 50 mph at 7,000 feet)
- Very warm, moist air near the ground with unusually cooler air aloft
- A forcing mechanism such as a cold front or leftover weather boundary from previous shower or thunderstorm activity

Tornado damage severity is measured by the Fujita Tornado Scale, in which wind speed is not measured directly but rather estimated from the amount of damage. As of February 1, 2007, the National Weather Service began rating tornadoes using the Enhanced Fujita-scale (EF-scale), which allows surveyors to create more precise assessments of tornado severity. The EF-scale is summarized below:

**Table 13: Enhanced Fujita Scale**

<b>Fujita Scale</b>			<b>Derived</b>		<b>Operational EF Scale</b>	
<b>F Number</b>	<b>Fastest ¼ mile (mph)</b>	<b>3-second gust (mph)</b>	<b>EF Number</b>	<b>3-second gust (mph)</b>	<b>EF Number</b>	<b>3-second gust (mph)</b>
0	40 – 72	45 – 78	0	65 – 85	0	65 – 85
1	73 – 112	79 – 117	1	86 – 109	1	86 – 110
2	113 – 157	118 – 161	2	110 – 137	2	111 – 135
3	158 – 207	162 – 209	3	138 – 167	3	136 – 165
4	208 – 260	210 – 261	4	168 – 199	4	166 – 200
5	261 – 318	262 – 317	5	200 – 234	5	Over 200

Source: Massachusetts State Hazard Mitigation Plan, 2013

The frequency of tornadoes in eastern Massachusetts is low; on average, there are six tornadoes that touchdown somewhere in the Northeast region every year. The strongest tornado in Massachusetts history was the Worcester Tornado in 1953 (NESEC). Recent tornado events in Massachusetts were in Springfield in 2011 and in Revere in 2014. The Springfield tornado caused significant damage and resulted in four deaths in June of 2011. The Revere tornado touched down in Chelsea just south of Route 16, moved north into Revere's business district along Broadway, and ended near the intersection of Routes 1 and 60. The path was approximately two miles long and 3/8 mile wide, with wind speeds up to 120 miles per hour. Approximately 65 homes had substantial damages and 13 homes and businesses were rendered uninhabitable.

Since 1950, there have been eleven tornadoes in Norfolk County recorded by the Tornado History Project. There have been one F3 and one F2, and three F1 tornadoes. These eleven tornadoes resulted in a total of one fatality and 23 injuries and \$4.1 million in damages, as summarized in Table 14.

**Table 14: Tornado Records for Norfolk County**

Date	Fujita	Fatalities	Injuries	Width	Length	Damage
June 1953	3	0	17	667	28	\$500K – 5M
11/21/1956	2	0	0	17	0.1	\$500-\$5000
8/9/1972	1	1	6	30	4.9	\$5K-\$50K
9/6/1973	1	0	0	10	1.1	\$5K-\$50K
7/10/1989	0	0	0	23	0.1	\$500-\$5000
5/18/1990	0	0	0	10	0.2	\$500-\$5000
5/18/1990	0	0	0	10	0.2	\$500-\$5000
6/30/2001	0	0	0	80	0.1	-
8/21/2004	1	0	0	40	6	\$1,500,000
5/9/2013	0	0	0	50	0.38	\$20,000
06/23/2015	0	0	0	200	0.48	-

Source: The Tornado History Project

Buildings constructed prior to current building codes may be more vulnerable to damages caused by tornadoes. Evacuation of impacted areas may be required on short notice. Sheltering and mass feeding efforts may be required along with debris clearance, search and rescue, and emergency fire and medical services. Key routes may be blocked by downed trees and other debris, and widespread power outages are also typically associated with tornadoes.

Although tornadoes are a potential town-wide hazard in Braintree, tornado impacts are relatively localized compared to severe storms and hurricanes. Damages from any tornado in Braintree would greatly depend on the track of the tornado.

Based on the record of previous occurrences since 1956, Tornado events in Braintree are a low frequency event as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur from once in 50 years to once in 100 years (1% to 2% per year).

### **CLIMATE CHANGE AND TORNADOS**

According to the SHMCAP, it is possible that severe thunderstorms which can include tornadoes may increase in frequency and intensity. However, scientists have less confidence in the models that seek to project future changes in tornado activity.

### **NOR'EASTERS**

A northeast coastal storm, known as a nor'easter, is typically a large counter-clockwise wind circulation around a low-pressure center. Featuring strong northeasterly winds blowing in from the ocean over coastal areas, nor'easters are relatively common in the winter months in New England occurring one to two times a year. The storm radius of a nor'easter can be as much as 1,000 miles and these storms feature sustained winds of 10 to 40 mph with gusts of up to 70 mph. These storms are accompanied by heavy rain or snow, depending on temperatures.

Previous occurrences of nor'easters include the following which are listed in the Massachusetts State Hazard Mitigation Plan from 2013:

**Table 15: Nor'easter Events for Massachusetts, 1978 to 2011**

<b>Nor'easter Event</b>	<b>Date</b>
Blizzard of 1978	February 1978
Severe Coastal Storm ("Perfect Storm")	October 1991
Great Nor'easter of 1992	December 1992
Blizzard/Nor'easter	January 2005
Coastal Storm/Nor'easter	October 2005
Severe Storms, Inland & Coastal Flooding/Nor'easter	April 2007
Winter Storm/Nor'easter	January 2011
Severe Storm/Nor'easter	October 2011

Many of the historic flood events identified in the previous section were precipitated by nor'easters, including the "Perfect Storm" event in 1991. More recently, blizzards in February 2013, January 2015, and in March 2018 were large nor'easters that caused significant snowfall amounts.

Braintree is vulnerable to both the wind and precipitation that accompany nor'easters. High winds can cause damage to structures, fallen trees, and downed power lines leading to power outages. Intense rainfall can overwhelm drainage systems causing localized flooding of rivers and streams as well as urban stormwater ponding and localized flooding. Fallen tree limbs as well as heavy snow accumulation and intense rainfall can impede local transportation corridors, and block access for emergency vehicles. Nor'easters are also a cause of coastal flooding.

The entire Town of Braintree could be at risk from the wind, rain, or snow impacts from a nor'easter, depending on the track and radius of the storm. Based on the record of previous occurrences, nor'easters in Braintree are high frequency events as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in 5 years (greater than 20% per year).

### **NOR'EASTERS AND CLIMATE**

As with hurricanes, warmer ocean water and air will provide more fuel for storms. According to the SHMCAP it appears that Atlantic coast nor'easters are increasing in frequency and intensity.

### **SEVERE THUNDERSTORMS**

While less severe than the other types of storms discussed, thunderstorms can lead to localized damage and represent a hazard risk for communities. A thunderstorm typically features lightning, strong winds, rain, and/or hail. Thunderstorms sometime give rise to tornados. On average, these storms are only around 15 miles in diameter and last for about 30 minutes. A severe thunderstorm can include winds of close to 60 mph and rain sufficient to produce flooding. The town's entire area is potentially subject to severe thunderstorms.

The best available data on previous occurrences of thunderstorms in Braintree is for Norfolk County through the National Climatic Data Center (NCDC). Between the years 1995 and 2016, NCDC records show 63 thunderstorm events in Norfolk County (Table 16). These storms resulted in a total of \$1,055,500 in property damages. There were no injuries or deaths reported.

**Table 16: Norfolk County Thunderstorm Events, 1995 to 2018**

<b>Date</b>	<b>Magnitude*</b>	<b>Deaths</b>	<b>Injuries</b>	<b>Damage (\$)</b>
4/4/1995	53	0	0	0
7/15/1995	55	0	0	0
10/28/1995	0	0	0	0
5/21/1996	60	0	0	0
5/31/1998	50	0	0	0
6/26/1998	50	0	0	20000
7/20/1998	50	0	0	0
7/23/1998	50	0	0	0
7/6/1999	70	0	0	0
7/24/1999	50	0	0	0
8/5/1999	50	0	0	0
4/9/2000	61	0	0	0
6/2/2000	50	0	0	0
6/27/2000	50	0	0	0
7/18/2000	55	0	0	0
8/10/2000	50	0	0	0
6/30/2001	50	0	0	0
8/10/2001	50	0	0	20000
6/16/2002	50	0	0	5000
7/15/2002	62	0	0	25000
7/23/2002	50	0	0	7000
8/21/2004	50	0	0	25000
8/5/2005	50	0	0	25000
8/14/2005	50	0	0	20000
5/21/2006	52	0	0	35000
6/1/2006	50	0	0	15000
6/23/2006	50	0	0	15000
7/4/2006	50	0	0	40000
7/21/2006	50	0	0	15000
7/28/2006	50	0	0	20000
8/2/2006	50	0	0	55000
6/28/2007	50	0	0	0
7/28/2007	50	0	0	0
8/17/2007	50	0	0	0
6/24/2008	50	0	0	5000
7/2/2008	54	0	0	20000
8/3/2008	50	0	0	1000
9/9/2008	50	0	0	1000
5/24/2009	50	0	0	1000
6/27/2009	50	0	0	10000

<b>Date</b>	<b>Magnitude*</b>	<b>Deaths</b>	<b>Injuries</b>	<b>Damage (\$)</b>
7/7/2009	50	0	0	500
7/8/2009	50	0	0	1000
7/31/2009	50	0	0	26000
6/6/2010	53	0	0	10000
6/20/2010	58	0	0	113000
6/24/2010	50	0	0	1000
8/19/2011	50	0	0	7000
6/23/2012	50	0	0	41000
8/10/2012	50	0	0	5000
8/15/2012	40	0	0	500
6/17/2013	50	0	0	11000
7/29/2013	50	0	0	20500
7/3/2014	50	0	0	20000
7/28/2014	60	0	0	50000
6/23/2015	50	0	0	5000
8/4/2015	50	0	0	30000
8/15/2015	50	0	0	35000
2/25/2016	56	0	0	94000
6/7/2016	50	0	0	10000
7/18/2016	50	0	0	90000
7/22/2016	50	0	0	65000
7/23/2016	40	0	0	35000
8/14/2016	50	0	0	5000
04/01/2017		0	0	5000
07/12/2017		0	0	0
07/18/2017		0	0	1000
08/02/2017		0	0	0
09/30/2017		0	0	10,000
10/25/2017		0	0	0
01/12/2018		0	0	0
01/13/2018		0	0	0
04/16/2018		0	0	0
<b>Total</b>		<b>0</b>	<b>0</b>	<b>\$1,071,500</b>

\*Magnitude refers to maximum wind speed

Source: NOAA, National Climatic Data Center

Severe thunderstorms are a town-wide hazard for Braintree. The town's vulnerability to severe thunderstorms is similar to that of nor'easters. High winds can cause falling trees and power outages, as well as obstruction of key routes and emergency access. Heavy precipitation may also cause localized flooding, both riverine and urban drainage related.

Based on the record of previous occurrences, severe thunderstorms in Braintree are high frequency events as defined by the 2013 Massachusetts State Hazard Mitigation Plan. This hazard may occur more frequently than once in 5 years (greater than 20% per year).

### **THUNDERSTORMS AND CLIMATE**

As noted previously, the intensity of rainfall events has increased significantly, and those trends are expected to continue. The SHMCAP does not specifically address whether climate will affect the intensity or frequency of thunderstorms.

## **WINTER STORMS**

Winter storms, including heavy snow, blizzards, and ice storms, are the most common and most familiar of the region's hazards that affect large geographic areas. The majority of blizzards and ice storms in the region cause more inconvenience than they do serious property damage, injuries, or deaths. However, periodically, a storm will occur which is a true disaster, and necessitates intense large-scale emergency response. The impacts of winter storms are often related to the weight of snow and ice, which can cause roof collapses and also causes tree limbs to fall. This in turn can cause property damage and potential injuries. Power outages may also result from fallen trees and utility lines.

Winter storms are a potential town-wide hazard in Braintree. Map 6 in Appendix A indicates that the average annual average snowfall in most of Braintree is between 48 and 72 inches. A number of public safety issues can arise during snow storms. Impassible streets are a challenge for emergency vehicles and affect residents and employers. Snow-covered sidewalks force people to walk in streets, which are already less safe due to snow, slush, puddles, and ice. Large piles of snow can also block sight lines for drivers, particularly at intersections. Refreezing of melting snow can cause dangerous roadway conditions. In addition, transit operations may be impacted, as they were in the 2015 blizzards which caused the closure of the MBTA system for one day and limited services on the commuter rail for several weeks.

### **HEAVY SNOW AND BLIZZARDS**

A blizzard is a winter snow storm with sustained or frequent wind gusts to 35 mph or more, accompanied by falling or blowing snow which reduces visibility to or below  $\frac{1}{4}$  mile. These conditions must be the predominant condition over a three hour period. Extremely cold temperatures are often associated with blizzard conditions, but are not a formal part of the definition. The hazard related to the combination of snow, wind, and low visibility significantly increases when temperatures drop below 20 degrees. Winter storms are a combination hazard because they often involve wind, ice, and heavy snow fall. The National Weather Service defines "heavy snow fall" as an event generating at least four inches of snowfall within a 12 hour period. Winter storms are often associated with a Nor'easter event, a large counter-clockwise wind circulation around a low-pressure center often resulting in heavy snow, high winds, and rain.

The Northeast Snowfall Impact Scale (NESIS), developed by Paul Kocin of The Weather Channel and Louis Uccellini of the National Weather Service (Kocin and Uccellini, 2004), characterizes and ranks high impact northeast snowstorms. These storms have large areas of 10 inch snowfall accumulations and greater. NESIS has five categories: Extreme, Crippling, Major, Significant, and Notable. NESIS scores are a function of the area affected by the snowstorm, the amount of snow, and the number of people living in the path of the

storm. The largest NESIS values result from storms producing heavy snowfall over large areas that include major metropolitan centers. The NESIS categories are summarized below:

**Table 17: NESIS Categories**

Category	NESIS	Value Description
1	1 – 2.499	Notable
2	2.5 – 3.99	Significant
3	4 – 5.99	Major
4	6 – 9.99	Crippling
5	10+	Extreme

Source: Massachusetts State Hazard Mitigation Plan, 2013

The most significant winter storm in recent history was the “Blizzard of 1978,” which resulted in over three feet of snowfall and multiple day closures of roadways, businesses, and schools. In Braintree, blizzards and severe winter storms have occurred in the following years:

**Table 18: Severe Winter Storm Records for Massachusetts**

Severe Winter Storm Event	Date
Blizzard of 1978	February 1978
Blizzard of 1993	March 1993
Blizzard of 1996	January 1996
Severe Snow Storm	March 2001
Severe Snow Storm	December 2003
Severe Snow Storm	January 2004
Severe Snow Storm	January 2005
Severe Snow Storm	April 2007
Severe Snow Storm	December 2010
Severe Snow Storm	January 2011
Blizzard of 2013	February 2013
Blizzard of 2015	January 2015
Blizzard of 2016	January 2016
Blizzard of 2017	March 2017
Blizzard of 2018	March 2018

Source: National Oceanic and Atmospheric Administration

The Town of Braintree does not keep local records of winter storms. Data for Norfolk County, which includes Braintree, is the best available data to help understand previous occurrences and impacts of heavy snow events. According to National Climate Data Center (NCDC) records, from 1996 to 2017, Norfolk County experienced 75 heavy snowfall events, resulting in two deaths, one injury, and \$6.4 million dollars in property damage. See Table 19 for heavy snow events and impacts in Norfolk County.

**Table 19: Heavy Snow Events and Impacts in Norfolk County, 1996 to 2018**

<b>Date</b>	<b>Deaths</b>	<b>Injuries</b>	<b>Property Damage (\$)</b>
1/2/1996	0	0	-
1/7/1996	0	0	1,400,000
1/7/1996	0	0	2,000,000
1/10/1996	0	0	-
2/2/1996	0	0	-
2/16/1996	0	0	-
3/2/1996	0	0	-
3/7/1996	0	0	-
4/7/1996	0	0	-
4/9/1996	0	0	-
12/6/1996	0	0	-
1/11/1997	0	0	-
2/16/1997	0	0	-
3/31/1997	0	0	-
4/1/1997	0	1	2,500,000
12/23/1997	0	0	-
1/15/1998	0	0	-
12/24/1998	0	0	-
1/14/1999	0	0	-
2/25/1999	0	0	-
3/6/1999	0	0	-
3/15/1999	0	0	-
1/13/2000	0	0	-
2/18/2000	0	0	-
12/30/2000	0	0	-
1/20/2001	0	0	-
2/5/2001	0	0	-
3/5/2001	0	0	-
3/9/2001	0	0	-
3/26/2001	0	0	250,000
12/8/2001	0	0	-
12/5/2002	0	0	-
3/16/2004	0	0	-
2/21/2005	0	0	-
2/24/2005	0	0	-
12/13/2007	0	0	-
12/16/2007	0	0	7,500
12/19/2007	0	0	-
1/14/2009	0	0	36,000
1/14/2009	0	0	30,000
1/14/2009	0	0	55,000
1/27/2009	0	0	-
2/22/2009	0	0	-
12/19/2009	0	0	10,000
12/19/2009	0	0	3,000
12/31/2009	0	0	-
1/18/2009	0	0	-
1/19/2009	0	0	-
2/3/2009	0	0	-
3/1/2009	0	0	-
3/2/2009	0	0	-

<b>Date</b>	<b>Deaths</b>	<b>Injuries</b>	<b>Property Damage (\$)</b>
12/19/2009	0	0	-
2/16/2010	0	0	-
12/20/2010	0	0	-
1/12/2011	0	0	-
1/26/2011	0	0	-
1/21/2012	0	0	-
12/29/2012	0	0	5,000
2/8/2013	0	0	-
3/7/2013	0	0	-
3/18/2013	0	0	-
12/14/2013	0	0	-
12/17/2013	0	0	-
1/2/2014	0	0	-
1/21/2014	0	0	-
2/5/2014	0	0	-
2/15/2014	0	0	5,000
01/26/2015	0	0	-
02/02/2015	0	0	-
02/08/2015	0	0	-
02/14/2015	0	0	-
01/23/2016	0	0	-
02/05/2016	2	0	100,000
02/08/2016	0	0	-
04/04/2016	0	0	-
3/14/2017	0	0	-
<b>Total</b>	<b>2</b>	<b>1</b>	<b>6,401,500</b>

Source: NOAA, National Climatic Data Center

### ***Potential Heavy Snow and Blizzard Hazard Areas***

Blizzards are considered to be high frequency events based on past occurrences, as defined by the Massachusetts State Hazard Mitigation Plan, 2013. This hazard occurs more than once in five years, with a greater than 20% chance of occurring each year.

### **WINTER STORMS AND CLIMATE**

As with nor'easters, warmer ocean water and air will provide more fuel for storms. According to the SHMCAP changing atmospheric patterns favor the development of winter storms.

### **ICE STORMS**

The ice storm category covers a range of different weather phenomena that collectively involve rain or snow being converted to ice in the lower atmosphere leading to potentially hazardous conditions on the ground. Hail size typically refers to the diameter of the hailstones. Warnings and reports may report hail size through comparisons with real-world objects that correspond to certain diameters:

**Table 20: Hail Size Comparisons**

Description	Diameter (inches)
Pea	0.25
Marble or mothball	0.50
Penny or dime	0.75
Nickel	0.88
Quarter	1.00
Half dollar	1.25
Walnut or ping pong ball	1.50
Golf ball	1.75
Hen's egg	2.00
Tennis ball	2.50
Baseball	2.75
Tea cup	3.00
Grapefruit	4.00
Softball	4.50

While ice pellets and sleet are examples of these, the greatest hazard is created by freezing rain conditions, which is rain that freezes on contact with hard surfaces leading to a layer of ice on roads, walkways, trees, and other surfaces. The conditions created by freezing rain can make driving particularly dangerous and emergency response more difficult. The weight of ice on tree branches can also lead to falling branches damaging electric lines.

Town-specific data for previous ice storm occurrences are not collected by the Town of Braintree. The best available local data is for Norfolk County through the National Climatic Data Center. Norfolk County, which includes the Town of Braintree, experienced five events from 1965 to 2017.

**Table 21: Norfolk County Hail Events, 1965 to 2018**

Date	Magnitude*	Deaths	Injuries	Damage
6/8/1965	1.5	0	0	0
4/19/1969	2	0	0	0
9/6/1973	1.75	0	0	0
6/13/1987	0.75	0	0	0
7/7/1994	1.75	0	0	0
5/12/2015	0.75	0	0	0

\*Magnitude refers to diameter of hail stones in inches

Source: NOAA, National Climatic Data Center

Ice storms are considered to be medium frequency events based on past occurrences, and as defined by the Massachusetts State Hazard Mitigation Plan. This hazard occurs once in five years to once in 50 years, with a 2% to 20% chance of occurring each year.

### **ICE STORMS AND CLIMATE**

There is some indication that if winters warm, temperatures may be more likely to produce icing conditions.

## GEOLOGIC HAZARDS

Geologic hazards include earthquakes, landslides, sinkholes, subsidence, and unstable soils such as fill, peat, and clay. Town officials did not identify any problems with areas of geologic instability, such as sinkholes or subsidence. Although new construction under recent building codes generally will be built to seismic standards, there are still many structures in town which pre-date building code updates. Information on geologic hazards in Braintree can be found on Map 4 in Appendix B.

### EARTHQUAKES

Damage in an earthquake stems from ground motion, surface faulting, and ground failure in which weak or unstable soils, such as those composed primarily of saturated sand or silts, liquefy. The effects of an earthquake are mitigated by distance and ground materials between the epicenter and a given location. An earthquake in New England affects a much wider area than a similar earthquake in California due to New England's solid bedrock geology (NESEC). Seismologists use a magnitude scale known as the Richter scale to express the seismic energy released by each earthquake. The typical effects of earthquakes in various ranges are summarized below:

**Table 22: Richter Scale and Effects**

Richter Magnitudes	Earthquake Effects
Less than 3.5	Generally not felt, but recorded
3.5- 5.4	Often felt, but rarely causes damage
Under 6.0	At most slight damage to well-designed buildings. Can cause major damage to poorly constructed buildings over small regions.
6.1-6.9	Can be destructive in areas up to about 100 km. across where people live.
7.0- 7.9	Major earthquake. Can cause serious damage over larger areas.
8 or greater	Great earthquake. Can cause serious damage in areas several hundred meters across.

Source: Nevada Seismological Library (NSL), 2005

According to the State Hazard Mitigation Plan, New England experiences an average of five earthquakes per year. From 1668 to 2007, 355 earthquakes were recorded in Massachusetts (NESEC). Most have originated from the La Malbaie fault in Quebec or from the Cape Anne fault located off the coast of Rockport. The region has experienced larger earthquakes in the distant past, including a magnitude 5.0 earthquake in 1727 and a 6.0 earthquake that struck in 1755 off the coast of Cape Anne. More recently, a pair of damaging earthquakes occurred near Ossipee, NH in 1940. A 4.0 earthquake centered in Hollis, Maine in October 2012 was felt in the Boston area. Historic records of some of the more significant earthquakes in the region are shown in Table 23.

**Table 23: Historical Earthquakes in Massachusetts or Surrounding Area**

Location	Date	Magnitude
MA - Cape Ann	11/10/1727	5
MA - Cape Ann	12/29/1727	NA
MA - Cape Ann	2/10/1728	NA
MA - Cape Ann	3/30/1729	NA

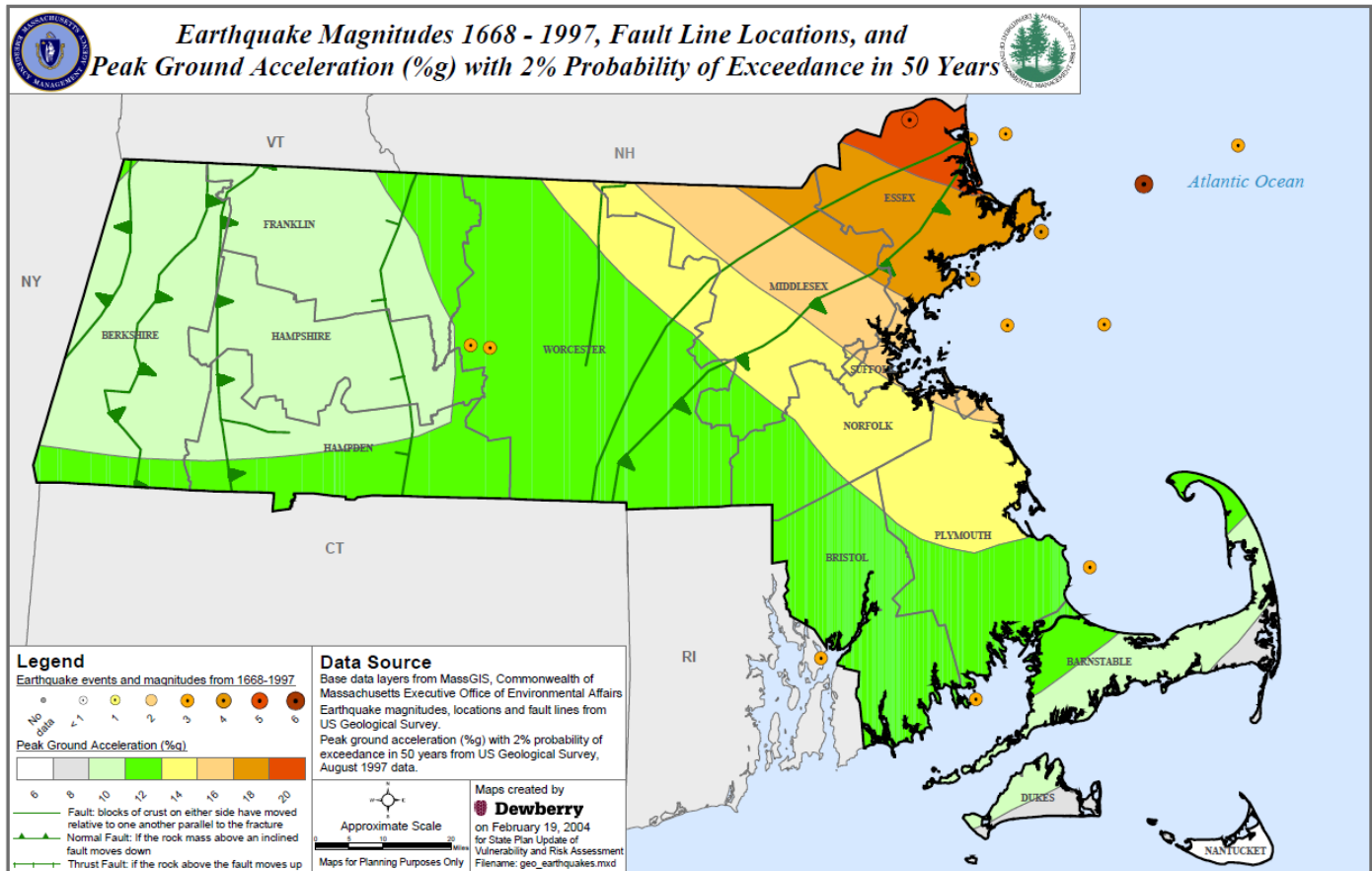
<b>Location</b>	<b>Date</b>	<b>Magnitude</b>
MA - Cape Ann	12/9/1729	NA
MA - Cape Ann	2/20/1730	NA
MA - Cape Ann	3/9/1730	NA
MA - Boston	6/24/1741	NA
MA - Cape Ann	6/14/1744	4.7
MA - Salem	7/1/1744	NA
MA - Off Cape Ann	11/18/1755	6
MA - Off Cape Cod	11/23/1755	NA
MA - Boston	3/12/1761	4.6
MA - Off Cape Cod	2/2/1766	NA
MA - Offshore	1/2/1785	5.4
MA - Wareham/Taunton	12/25/1800	NA
MA - Woburn	10/5/1817	4.3
MA - Marblehead	8/25/1846	4.3
MA - Brewster	8/8/1847	4.2
MA - Boxford	5/12/1880	NA
MA - Newbury	11/7/1907	NA
MA - Wareham	4/25/1924	NA
MA - Cape Ann	1/7/1925	4
MA - Nantucket	10/25/1965	NA
MA - Boston	12/27/74	2.3
MA - Nantucket	4/12/12	4.5
ME - Hollis	10/17/12	4.0

Source: Boston HIRA

One measure of earthquake risk is ground motion, which is measured as maximum peak horizontal acceleration, expressed as a percentage of gravity (%g). The range of peak ground acceleration in Massachusetts is from 10 %g to 20 %g, with a 2% probability of exceedance in 50 years. Braintree is in the middle part of the range for Massachusetts, at 14 %g to 16 %g, making it a relatively moderate area of earthquake risk within the state, although the state as a whole is considered to have a low risk of earthquakes compared to the rest of the country. There have been no recorded earthquake epicenters within Braintree.

Although New England has not experienced a damaging earthquake since 1755, seismologists state that a serious earthquake occurrence is possible. There are five seismological faults in Massachusetts, but there is no discernible pattern of previous earthquakes along these fault lines. Earthquakes occur without warning and may be followed by aftershocks. The majority of older buildings and infrastructure were constructed without specific earthquake resistant design features.

**Figure 4: State of Massachusetts Earthquake Probability Map**



Earthquakes are a hazard with multiple impacts beyond the obvious building collapse. Buildings may suffer structural damage which may or may not be readily apparent. Earthquakes can cause major damage to roadways, making emergency response difficult. Water lines and gas lines can break, causing flooding and fires. Another potential vulnerability is equipment within structures. For example, a hospital may be structurally engineered to withstand an earthquake, but if the equipment inside the building is not properly secured, the operations at the hospital could be severely impacted during an earthquake. Earthquakes can also trigger landslides.

According to the Boston College Weston Observatory, in most parts of New England, there is a one in ten chance that a potentially damaging earthquake will occur in a 50 year time period. The Massachusetts State Hazard Mitigation Plan classifies earthquakes as "very low" frequency events that occur less frequently than once in 100 years, or a less than 1% chance per year. Earthquakes are a potential town-wide hazard in Braintree.

Although new construction under the most recent building codes generally will be built to seismic standards, much of the development in the town pre-dates the most recent building code. Potential earthquake damages to Braintree have been estimated using HAZUS-MH. Total building damages are estimated at \$145.5 million for a 5.0 magnitude earthquake and \$795 million for a 7.0 magnitude earthquake. Other potential impacts are detailed in Table 34.

## LANDSLIDES

According to the U.S. Geological Survey, “The term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors.” Among the contributing factors are: erosion by rivers or ocean waves over steepened slopes; rock and soil slopes weakened through saturation by snowmelt or heavy rains; earthquake created stresses that make weak slopes fail; excess weight from accumulation of rain or snow; and stockpiling of rock or ore from waste piles or man-made structures.

Landslides can result from human activities that destabilize an area or can occur as a secondary impact from another natural hazard, such as flooding. In addition to structural damage to buildings and the blockage of transportation corridors, landslides can lead to sedimentation of water bodies. Typically, a landslide occurs when the condition of a slope changes from stable to unstable. Natural precipitation such as heavy snow accumulation, torrential rain, and run-off may saturate soil, creating instability enough to contribute to a landslide. A lack of vegetation and root structure that normally stabilize soil can destabilize hilly terrain.

There is no universally accepted measure of landslide extent, but it has been represented as a measure of the destructiveness. The table below summarizes the estimated intensity for a range of landslides. Fast moving rock falls have the highest intensity while slow moving landslides have the lowest intensity.

**Table 24: Landslide Volume and Velocity**

Estimate Volume (m <sup>3</sup> )	Expected Landslide Velocity		
	Fast moving (rock fall)	Rapid moving (debris flow)	Slow moving (slide)
<0.001	Slight intensity	--	--
<0.5	Medium intensity	--	--
>0.5	High intensity	---	--
<500	High intensity	Slight intensity	--
500-10,000	High intensity	Medium intensity	Slight intensity
10,000 – 50,000	Very high intensity	High intensity	Medium intensity
>500,000	--	Very high intensity	High intensity
>>500,000	--	--	Very high intensity

Source: *A Geomorphological Approach to the Estimation of Landslide Hazards and Risks in Umbria, Central Italy*, M. Cardinali et al, 2002

Braintree has been classified as having a low incidence of landslides although the northern half of Braintree is classified as having moderate susceptibility to landslides (see Map 4, Appendix B). The town does not have records of any damages caused by landslides. Should a landslide occur in the future, the type and degree of impacts would be highly localized. The town’s vulnerabilities could include damage to structures, damage to transportation and other infrastructure, and localized road closures. Injuries and casualties, while possible, would be unlikely given the low extent and impact of landslides in Braintree. Based on past occurrences and the Massachusetts Hazard Mitigation Plan, landslides are low frequency events that can occur once in 50 to 100 years (a 1% to 2% chance of occurring each year).

## **LANDSLIDES AND CLIMATE**

Increased precipitation could result in more frequent saturated soils which are conducive to landslides. Drought may also increase the likelihood of landslides if loss of vegetation decreases soil stability.

## **FIRE-RELATED HAZARDS**

A brush fire is an uncontrolled fire occurring in a forested or grassland area. In the Boston Metro region these fires rarely grow to the size of a wildfire, as seen more typically in the western U.S. As their name implies, brush fires typically burn no more than the underbrush of a forested area. There are three different classes of wildfires:

- Surface fires are the most common type and burn along the floor of a forest, moving slowly and killing or damaging trees
- Ground fires are usually started by lightning and burn on or below the forest floor
- Crown fires spread rapidly by wind, jumping along the tops of trees

Wildfire season can begin in March and usually ends in late November. The majority of wildfires typically occur in April and May, when most vegetation is void of any appreciable moisture, making them highly flammable. Once "green-up" takes place in late May to early June, the fire danger usually is reduced somewhat.

A wildfire differs greatly from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to unexpectedly change direction, and its ability to jump gaps such as roads, rivers, and fire breaks.

These fires can present a hazard where there is the potential for them to spread into developed or inhabited areas, particularly residential areas where sufficient fuel materials might exist to allow the fire the spread into homes. Protecting structures from fire poses special problems, and can stretch firefighting resources to the limit. If heavy rains follow a fire, other natural disasters can occur, including landslides, mudflows, and floods. If the wild fire destroys the ground cover, then erosion becomes one of several potential problems.

### **Potential Brushfire Hazard Areas**

State records (see Figure 5 below) indicate that Braintree experiences, on average, six to twelve brush fires of varying sizes annually, ranging from very small mulch fires to small woods fires. Within the past year, there were none that resulted in significant property damage. The most common cause of wildfires is the careless disposal of smoking materials and untended campfires.

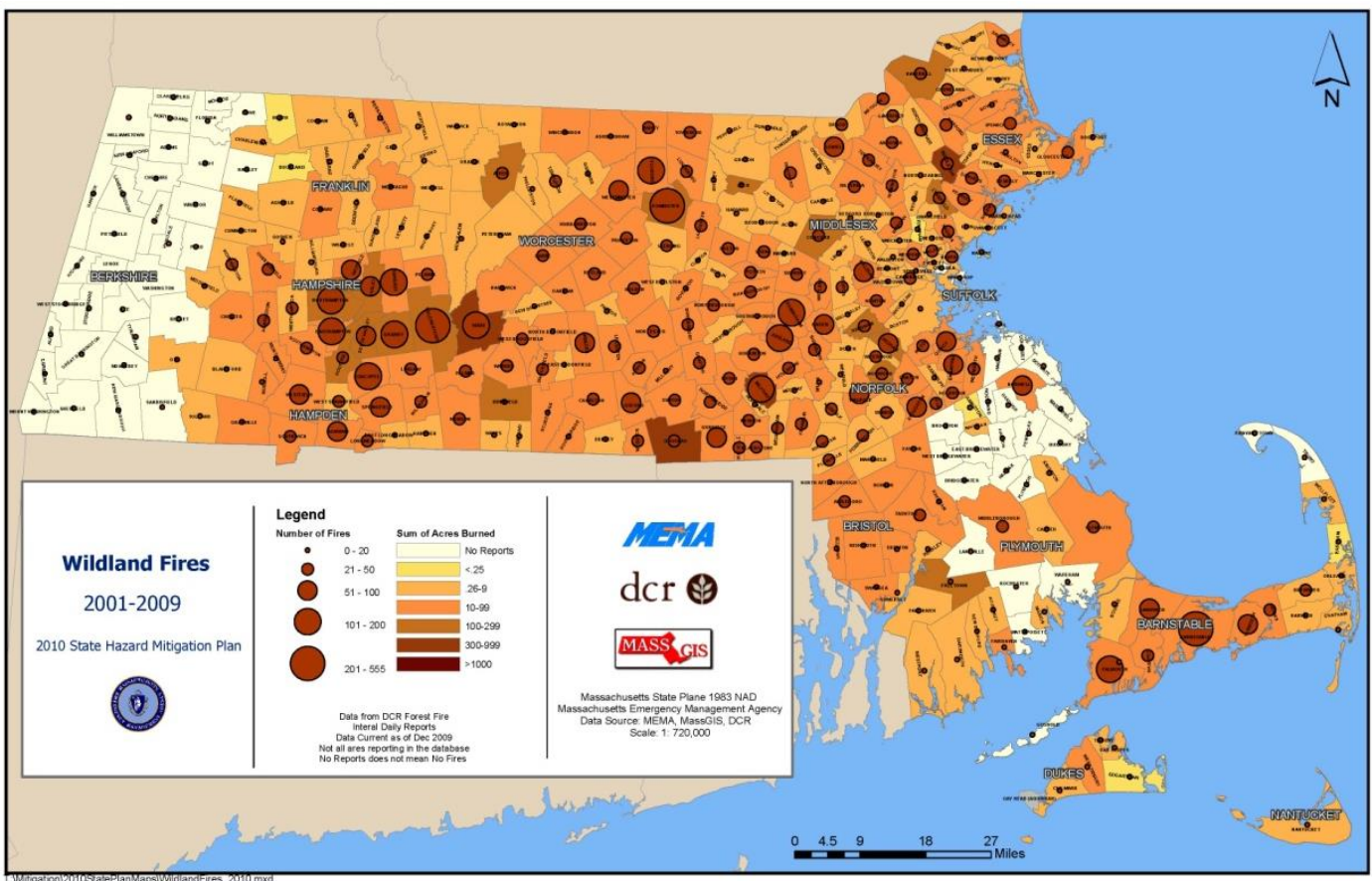
The following areas of town were identified as having the highest potential for brush fires. The numbers correspond to the numbers on Map 8, "Hazard Areas":

- 30. Town Forest
- 31. Pond Meadow
- 32. Gun Club
- 33. South Street/Hospital

34. Cranberry Pond Area
35. Smith Beach Marsh
36. Great Pond Pumping Station Land
37. Skyline Drive / Eaton's Pond Area— Potentially caused by untended campfires.
38. Hillside
39. School Trust Land
40. South Braintree Office Park Area
41. Wooded Area South of South Shore Plaza
42. Blue Hills Reservation, off Route 128

Wildfires in Massachusetts are measured by the number of fires and the sum of acres burned. The most recent data available for wildfires in Massachusetts, shown in Figure below, indicates that the wildfire extent in Braintree consists of 10 to 99 acres burned, with 51 to 100 recordable fires from 2001 to 2009. Less 1% of fires results in significant property damage. There have been no deaths as a result of brush fires.

**Figure 5: Massachusetts Wildfires, 2001 to 2009**



Based on past occurrences and the Massachusetts Hazard Mitigation Plan 2013, brushfires are of Medium frequency, events that occur from once in 5 years to once in 50 years (2% to 20% probability per year).

## CLIMATE AND FIRE HAZARDS

Drought and warmer temperatures may lead to an increase in wildfires if forests dry out and become more flammable.

### EXTREME TEMPERATURES

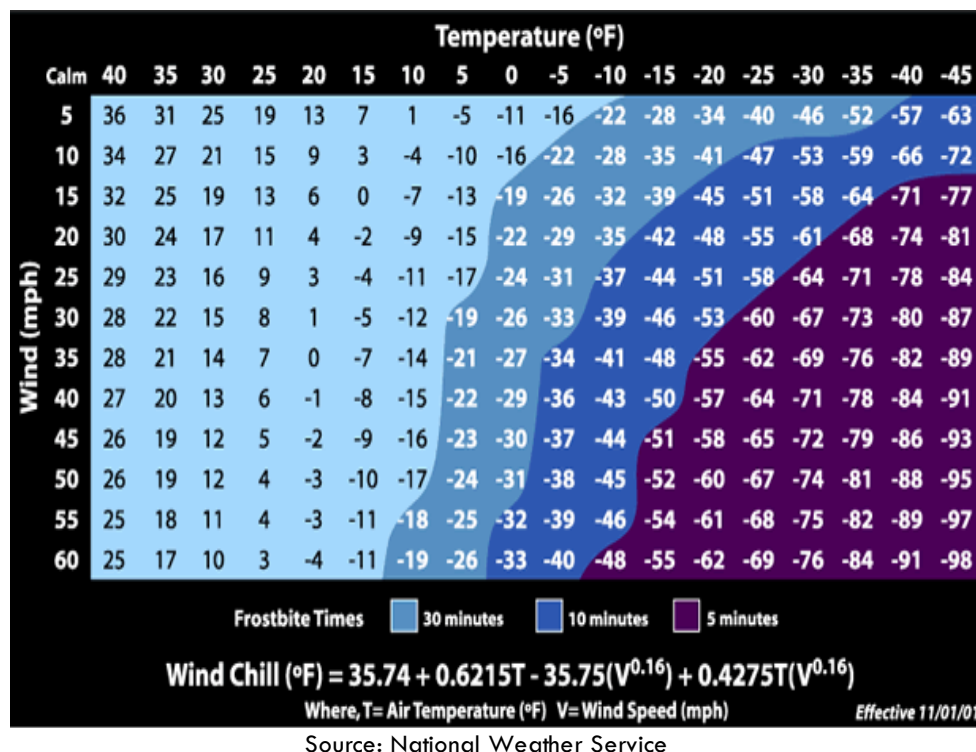
Extreme temperatures occur when either high temperature or low temperatures relative to average local temperatures occur. These can occur for brief periods of time and be acute, or they can occur over long periods of time where there is a long stretch of excessively hot or cold weather.

Braintree has four well-defined seasons. The seasons have several defining factors, with temperature one of the most significant. Extreme temperatures can be defined as those that are far outside of the normal seasonal ranges for Massachusetts. The average temperature for winter (December to February) in Massachusetts is 31.8°F. The average temperature for summer (June to August) is 71°F. Extreme temperatures are a town-wide hazard.

### EXTREME COLD

For extreme cold, temperature is typically measured using the Wind Chill Temperature Index, which is provided by the National Weather Service (NWS). The latest version of the index was implemented in 2001 and is meant to show how cold conditions feel on unexposed skin and can lead to frostbite. The index is provided in Figure below. Temperatures that drop decidedly below normal and wind speeds that increase can cause harmful wind-chill factors. The wind chill is the apparent temperature felt on exposed skin due to the combination of air temperature and wind speed.

Figure 6: Wind Chill Temperature Index and Frostbite Risk



Extreme cold is a dangerous situation that can result in health emergencies for susceptible people, such as those without shelter, those who are stranded, or those who live in homes that are poorly insulated or without heat.

The Town of Braintree does not collect data for previous occurrences of extreme cold. The best available local data are for Norfolk County, through the National Climatic Data Center (NCDC). There are three extreme cold events on record in February 2015 and 2016 for the county, which caused no deaths, no injuries, or property damage.

**Table 25: Norfolk County Extreme Cold and Wind Chill Occurrences**

Date	Deaths	Injuries	Damage (\$)
2/16/2015	0	0	0
2/13/2016	0	0	0
2/14/2016	0	0	0

Source: NOAA, National Climatic Data Center

### EXTREME HEAT

A heat wave in Massachusetts is defined as three or more consecutive days above 90°F. Another measure used for identifying extreme heat events is through a Heat Advisory from the NWS. These advisories are issued when the heat index (Figure 7) is forecast to exceed 100°F for two or more hours; an excessive heat advisory is issued if the forecast predicts the temperature to rise above 105°F.

**Figure 7: Heat Index Chart**

		Temperature (°F)															
Relative Humidity (%)		80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
	40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
	45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
	50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
	55	81	84	86	89	93	97	101	106	112	117	124	130	137			
	60	82	84	88	91	95	100	105	110	116	123	129	137				
	65	82	85	89	93	98	103	108	114	121	128	136					
	70	83	86	90	95	100	105	112	119	126	134						
	75	84	88	92	97	103	109	116	124	132							
	80	84	89	94	100	106	113	121	129								
	85	85	90	96	102	110	117	126	135								
	90	86	91	98	105	113	122	131									
	95	86	93	100	108	117	127										
	100	87	95	103	112	121	132										
Category		Heat Index		Health Hazards													
Extreme Danger		130 °F – Higher		Heat Stroke or Sunstroke is likely with continued exposure.													
Danger		105 °F – 129 °F		Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.													
Extreme Caution		90 °F – 105 °F		Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.													
Caution		80 °F – 90 °F		Fatigue possible with prolonged exposure and/or physical activity.													

The Town of Braintree does not collect data on excessive heat occurrences. The best available local data are for Norfolk County, through the National Climatic Data Center. From 1999 to 2011, there have been

a total of nine excessive heat days, one of which resulted in two reported deaths, but no additional injuries, or property damage (see Table 26).

**Table 26: Norfolk County Extreme Heat Occurrences**

<b>Date</b>	<b>Deaths</b>	<b>Injuries</b>	<b>Damage (\$)</b>
6/7/1999	0	0	0
7/5/1999	2	0	0
7/16/1999	0	0	0
7/17/1999	0	0	0
7/18/1999	0	0	0
9/7/1999	0	0	0
9/8/1999	0	0	0
7/6/2010	0	0	0
7/22/2011	0	0	0
<b>Total</b>	<b>2</b>	<b>0</b>	<b>0</b>

Source: NOAA, National Climatic Data Center

Extreme temperatures are medium frequency events based on past occurrences, and as defined by the 2013 Massachusetts State Hazard Mitigation Plan. Both extreme cold and hot weather events occur between once in five years to once in 50 years, or a 2% to 20% chance of occurring each year.

#### **EXTREME TEMPERATURES AND CLIMATE**

Extreme cold events are predicted to decrease in the future, while extreme heat is projected to increase. Future temperature projections for the Boston Harbor Basin (Figure 8) are shown below. The projections show an increase in average temperatures and an increasing likelihood of heat waves, as indicated by the increased number of days over 90 and 100 degrees each year.

The projected increase in extreme heat and heat waves is the source of one of the key health concerns related to climate change. Prolonged exposure to high temperatures can cause heat-related illnesses, such as heat cramps, heat exhaustion, heat stroke, and death. Heat exhaustion is the most common heat-related illness and if untreated, it may progress to heat stroke. People who perform manual labor, particularly those who work outdoors, are at increased risk for heat-related illnesses. Prolonged heat exposure and the poor air quality and high humidity that often accompany heat waves can also exacerbate pre-existing conditions, including respiratory illnesses, cardiovascular disease, and mental illnesses.

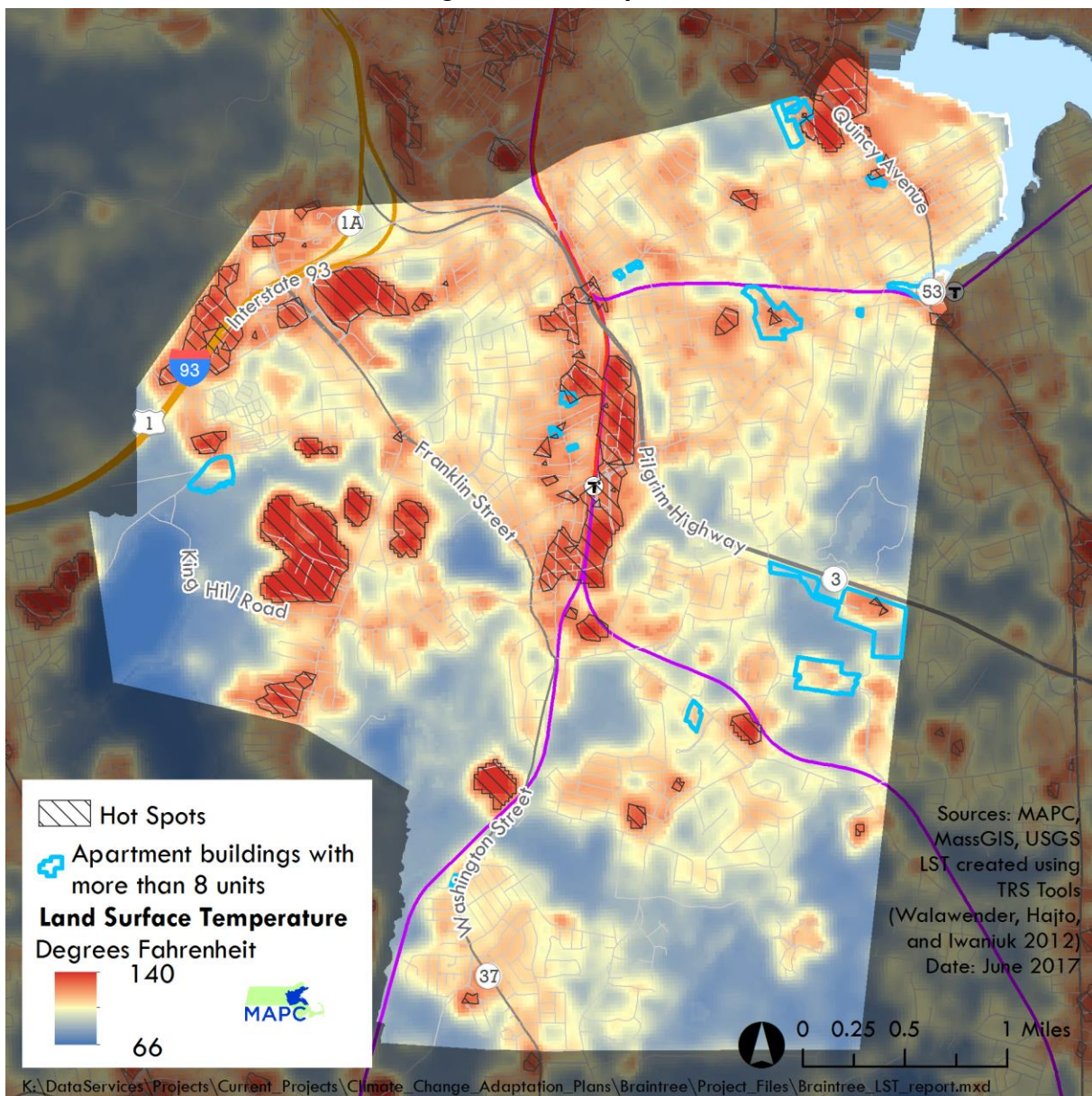
The senior population is often at elevated risk due to a high prevalence of pre-existing and chronic conditions. People who live in older housing stock (as is often the case with public housing), and in housing without air conditioning have increased vulnerability to heat-related illnesses. Power failures are more likely to occur during heat waves, affecting the ability of residents to remain cool during extreme heat. Individuals with pre-existing conditions and those who require electric medical equipment may be at increased risk during a power outage.

**Figure 8. Projected Temperature Change for the Boston Harbor Basin**

<b>Projected Temperatures Boston Harbor Watershed</b>					
<b>Temperature F°</b>	<b>Observed Baseline 1971-2000</b>	<b>Predicted 2020-2049</b>	<b>Predicted 2040-2069</b>	<b>Predicted 2060-2089</b>	<b>Predicted 2080-2099</b>
<b>Annual temperature</b>	<b>50°</b>	<b>52-54°</b>	<b>53-56°</b>	<b>53-59°</b>	<b>54-61°</b>
<b>Days over 90° (days/year)</b>	<b>8</b>	<b>13-23</b>	<b>16-37</b>	<b>17-57</b>	<b>19-75</b>
<b>Days over 100° (days/year)</b>	<b>0.05</b>	<b>.29-2</b>	<b>.37-4</b>	<b>.52-9</b>	<b>.60-16</b>

Due to what is termed the “heat island effect”, areas with less shade and more dark surfaces (pavement and roofs) will experience even hotter temperatures; these surfaces absorb heat during the day and release it in the evening, keeping nighttime temperatures warmer as well. Figure 9 displays land surface temperature derived from satellite imagery on July 13, 2016, when the high temperature at Logan Airport was 92°F. It is important to note that air temperature just several feet above the ground varies from ground temperature. The range of land surface temperatures is much greater than that of air temperatures. Black pavements can attain temperatures far higher than the air temperature several feet above the ground. In contrast, vegetation or water can be much cooler than air temperatures. Thus the air temperature people experience will not be as hot as the hottest temperatures shown, nor as cool as the coolest areas shown.

**Figure 9. Heat Impacts**



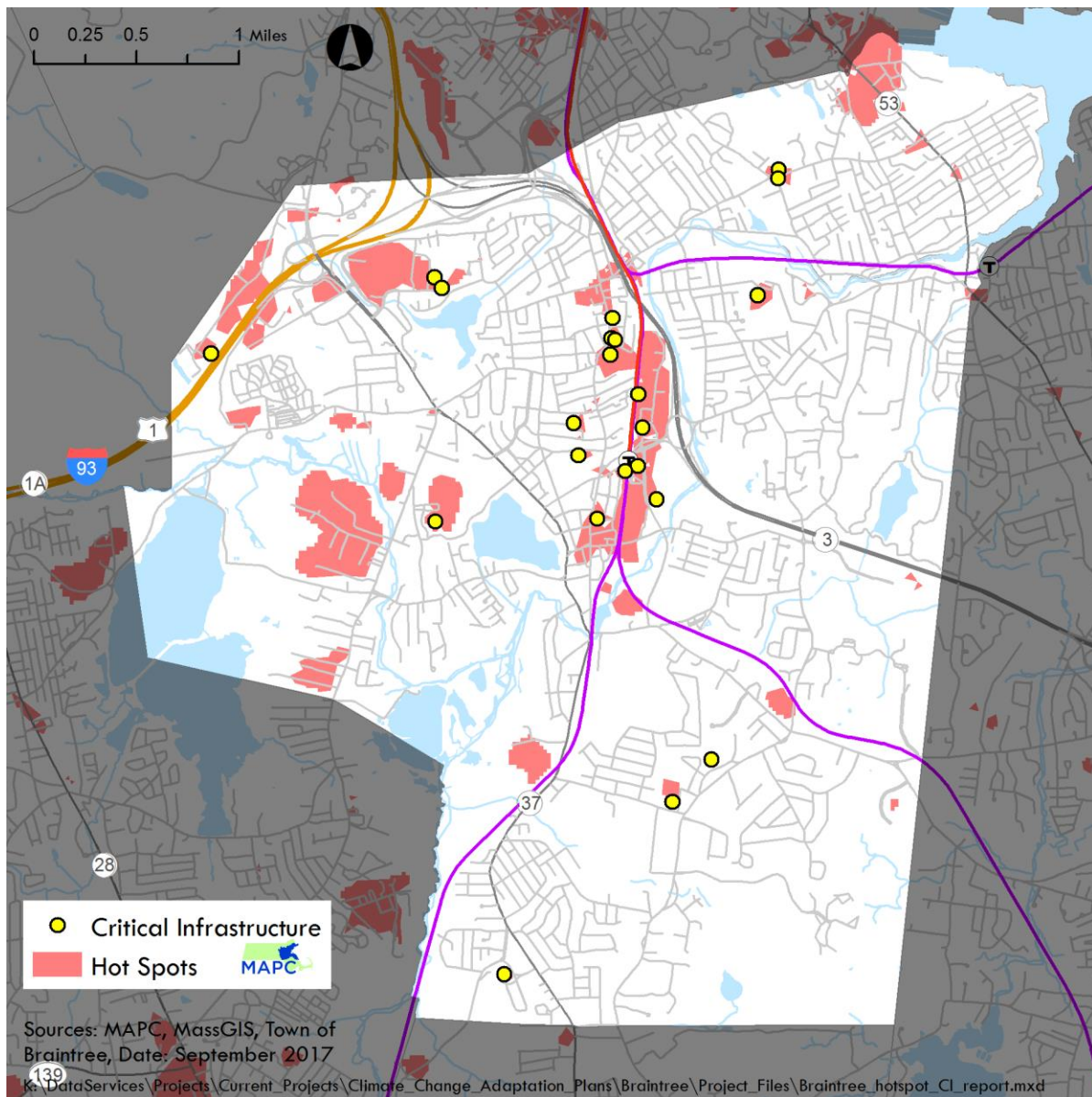
**Land Surface Temperature on July 13<sup>th</sup>, 2016, when high temperature at Logan Airport was 92 degrees Fahrenheit.**

The temperature display reveals that the hottest areas in Braintree coincide, for the most part, with locations that are zoned for commercial and industrial use. Given the generally suburban nature of the residential areas in Braintree, this is not surprising. There are, however, several residential locations, including Lenox Farms, the McCusker Drive area, Skyline Drive, and the area between Washington Street and the Braintree MBTA station that, while not as hot as the commercial and industrial areas, nevertheless are identified as “hot spots: part of the hottest 5% of land area in the MAPC region.

Residential areas adjacent to business or industrial areas will be hotter than other locations. Notably, all of the Braintree public schools, with the exception of Highlands and Morrison Elementary Schools, are located in hot spots, as are Thayer Academy, the Thayer Academy South Athletic Campus, and the Archbishop

Williams Stadium. Figure 10, and the accompanying Table 27, identify critical facilities from the Braintree Hazard Mitigation Plan and from MassGIS, in hot spot locations.

**Figure 10. Critical Facilities in Temperature Hot Spots**



"Hot spots" identify the hottest 5% of land in the MAPC region.

**Table 27. Critical Facilities in Temperature Hot Spots**

Facility	Location
Ross Elementary School	20 Hayward Street
Mary Flaherty School	99 Lakeside Drive
East Middle School	305 River Street
Hollis Elementary School	482 Washington Street
Monatiquot Elementary School	25 Brow Avenue
Thayer Academy	745 Washington Street
St Francis Of Assisi	850 Washington Street

Braintree High	128 Town Street
SEAMASS Transfer Station	257 Ivory Street
Railyards	Ivory Street
Liberty Elementary School	49 Proctor Road
South Middle School	232 Peach Street
Northeast Specialty Hospital	2001 Washington Street
Fire Station # 3	1 Hayward Street
Verizon Telephone Exchange	505 Washington Street
Hugs Plus	460 Washington Street
Kinder-Care School	10 Webster Road
Braintree Medical Facility Center	340 Wood Road
Heliport	South Shore Plaza
Electric Substation	South Shore Plaza Road
Braintree MBTA Station	Ivory Street
University Of Phoenix-Boston	100 Grossman Drive

## **DROUGHT**

Drought is a temporary irregularity in precipitation and differs from aridity since the latter is restricted to low rainfall regions and is a permanent feature of climate. Drought is a period characterized by long durations of below normal precipitation. Drought conditions occur in virtually all climatic zones, yet its characteristics vary significantly from one region to another since it is relative to the normal precipitation in that region. Drought can affect agriculture, water supply, aquatic ecology, wildlife, and plant life.

In Massachusetts, droughts are caused by the prevalence of dry northern continental air and a decrease in coastal- and tropical-cyclone activity. During the 1960s, a cool drought occurred because dry air from the north caused lower temperatures in the springs and summers of 1962 through 1965. The northerly winds drove frontal systems to sea along the southeast coast and prevented the northeastern states from receiving moisture (U.S. Geological Survey). This is considered the record drought in Massachusetts modern history.

Average annual precipitation in Massachusetts is 44 inches per year, with approximately three to four inch average amounts for each month of the year. Regional monthly precipitation ranges from zero to 17 inches and statewide annual precipitation ranges from 30 to 61 inches. Thus, in the driest calendar year (1965), the statewide precipitation total of 30 inches was only 68% of the average total.

Although Massachusetts is relatively small, it has a number of distinct regions that experience significantly different weather patterns and react differently to the amounts of precipitation they receive. The DCR precipitation index divides the state into six regions: Western, Central, Connecticut River Valley, Northeast, Southeast, and Cape and Islands. Braintree is located in the Northeast region. Drought is a potential town-wide hazard in Braintree.

Five levels of drought have been developed to characterize drought severity: Normal, Advisory, Watch, Warning, and Emergency. These drought levels are based on the conditions of natural resources and are

intended to provide information on the current status of water resources. The levels provide a basic framework from which to take actions to assess, communicate, and respond to drought conditions.

The drought levels begin with a normal situation where data are routinely collected and distributed, move to heightened vigilance with increased data collection during an advisory, and to increased assessment and proactive education during a watch. Water restrictions might be appropriate at the watch or warning stage, depending on the capacity of each individual water supply system. A warning level indicates a severe situation and the possibility that a drought emergency may be necessary. A drought emergency is one in which mandatory water restrictions or use of emergency supplies become necessary. Drought levels are used to coordinate both state agency and local response to drought situations.

As dry conditions can have a range of different impacts, a number of drought indices are available to assess these various impacts. Massachusetts uses a multi-index system that takes advantage of several of these indices to determine the severity of a given drought or extended period of dry conditions. Drought level is determined monthly based on the number of indices which have reached a given drought level. Drought levels are declared on a regional basis for each of the six regions in Massachusetts. County by county or watershed-specific determinations may also be made.

A determination of drought level is based on seven indices:

1. Standardized Precipitation Index (SPI) reflects soil moisture and precipitation.
2. Crop Moisture Index (CMI) reflects soil moisture conditions for agriculture.
3. Keetch Byram Drought Index (KBDI) is designed for fire-potential assessment.
4. Precipitation Index is a comparison of measured precipitation amounts to historic normal precipitation.
5. The Groundwater Level Index is based on the number of consecutive month's groundwater levels below normal (lowest 25% of period of record).
6. The Stream flow Index is based on the number of consecutive months that stream flow levels are below normal (lowest 25% of period of record).
7. The Reservoir Index is based on the water levels of small, medium, and large index reservoirs across the state, relative to normal conditions for each month.

Determinations regarding the end of a drought or reduction of the drought level focus on two key drought indicators: precipitation and groundwater levels. These two factors have the greatest long-term impact on stream flow, water supply, reservoir levels, soil moisture, and potential for forest fires.

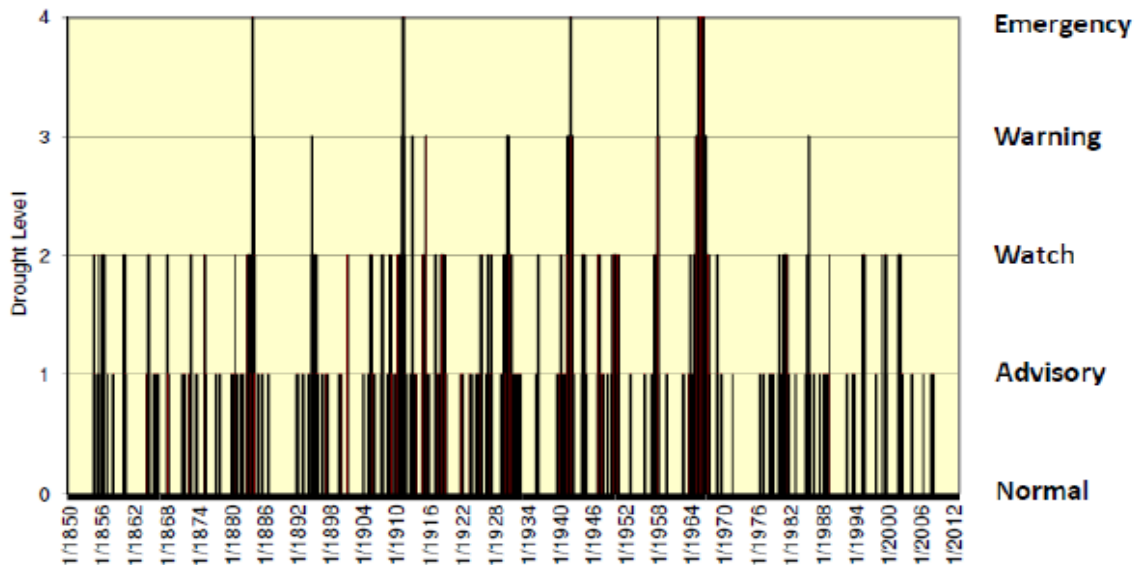
Braintree does not collect data relative to drought events. Because drought tends to be a regional natural hazard, this plan references state data as the best available data for drought. The statewide scale is a composite of the six regions in the state. Regional composite precipitation values are based on monthly values from six stations, and three stations in the smaller regions (Cape and Islands and West regions).

Figure 11 depicts the incidents of drought levels' occurrence in Massachusetts from 1850 to 2012 using the Standardized Precipitation Index (SPI) parameter alone. On a monthly basis, the state would have been in

a Drought Watch to Emergency condition 11% of the time between 1850 and 2012. Table 28 summarizes the chronology of major droughts since the 1920s.

Drought emergencies have been reached infrequently, with five events occurring in the period between 1850 and 2012: 1883, 1911, 1941, 1957, and 1965 to 1966. The drought period between 1965 and 1966 is viewed as the most severe drought to have occurred in modern times in Massachusetts because of its long duration. On a monthly basis over the 162-year period of record, there is a 1% chance of being in a drought emergency.

**Figure 11: Statewide Drought Levels using SPI Thresholds, 1850 to 2012**



Drought warning levels not associated with drought emergencies have occurred four times, in 1894, 1915, 1930, and 1985. On a monthly basis over the 162-year period of record, there is a 2% chance of being in a drought warning. Braintree was under a Drought Warning from August to November 2016.

Drought watches not associated with higher levels of drought generally have occurred in three to four years per decade between 1850 and 1950. In the 1980s, there was a lengthy drought watch level of precipitation between 1980 and 1981, followed by a drought warning in 1985. A frequency of drought watches at a rate of three years per decade resumed in the 1990s (1995, 1998, and 1999). In the 2000s, drought watches occurred in 2001 and 2002. The overall frequency of being in a drought watch is 8% on a monthly basis over the 162-year period of record.

**Table 28: Chronology of Major Droughts in Massachusetts**

Date	Area Affected	Recurrence Interval (years)	Remarks
1929 to 1932	Statewide	10 to >50	Water-supply sources altered in 13 communities. Multistate.
		15 to >50	More severe in eastern and extreme western Massachusetts. Multistate.
1957 to	Statewide	5 to 25	Record low water levels in observation wells,

1959			northeastern Massachusetts.
1961 to 1969	Statewide	35 to >50	Water-supply shortages common. Record drought. Multistate.
1980 to 1983	Statewide	10 to 30	Most severe in Ipswich and Taunton River basins; minimal effect in Nashua River basin. Multistate.
1958 to 1988	Housatonic River Basin	25	Duration and severity unknown. Streamflow showed mixed trends elsewhere.
2016-2017	Statewide	N/A	Drought declaration began in July 2016 with a Drought Watch which was upgraded to a Drought Warning in August 2016. The Central and Northeast regions were the most severely affected. Braintree is in the SE region.

Potential damages of a severe drought could include losses of landscaped areas if outdoor watering is restricted and potential loss of business revenues if water supplies were severely restricted for a prolonged period. As this hazard has never occurred to such a severe degree in Braintree, there are no data or estimates of potential damages, but under a severe long term drought scenario it would be reasonable to expect a range of potential damages from several million to tens of millions of dollars. Another potential vulnerability of droughts could be increased risk of wildfires.

The state has experienced emergency droughts five times between 1850 and 2012. Even though regional drought conditions may occur at a different interval than state data indicates, droughts remain primarily regional and state phenomena in Massachusetts. Emergency drought conditions over the 162 period of record in Massachusetts are a low frequency natural hazard event that can occur from once in 50 years to once in 100 years (1% to 2% chance per year) as defined by the Massachusetts State Hazard Mitigation Plan, 2013.

### **DROUGHT AND CLIMATE**

Climate projections indicate that slightly decreased summer rainfall, combine with higher temperatures and earlier snowmelt will increase the likelihood of more frequent or severe droughts in the late summer or early fall. Braintree relies on reservoirs for its water supply. The drought of 2016 reduced the reservoir level to 54%. This resulted in Phase Four (of Five) water use restrictions, banning all outside use of water. Phase Five restrictions are instituted when the reservoirs fall between 50% and 40% full. In Phase Five, all non-essential water use is prohibited.

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## **LAND USE AND DEVELOPMENT TRENDS**

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### **EXISTING LAND USE**

The most recent land use statistics available from the state are from aerial photography done in 2005. Change has certainly occurred in Braintree since then, but this data still provides the most detailed description of land use available. Table 29 shows the acreage and percentage of land in 29 categories. If the five residential categories are aggregated, residential uses make up 37% of the area of the town. Commercial and industrial combined make up 11% of the town. Recreation, urban public, and golf courses

comprise a total of 6%. The fifteen land use categories with less than 1% of land area represent a combined 3.5% of overall land use.

**Table 29: Town of Braintree, MA 2005 Land Use**

<b>Land Use Type</b>	<b>Acres</b>	<b>Percent</b>
Crop Land	3.3	<1%
Forest	2320.9	25.1%
Non-Forested Wetlands	333.3	3.6%
Mining	33.8	<1%
Open Land	47.0	<1%
Participatory Recreation	156.9	1.7%
Water-based Recreation	5.9	<1%
Multi-family Residential	419.1	4.5%
High Density Residential	861.3	9.3%
Medium Density Residential	1801.5	19.5%
Low Density Residential	282.5	3.1%
Very Low Density Residential	14.3	<1%
Salt Water Wetlands	8.5	<1%
Commercial	615.0	6.6%
Industrial	437.0	4.7%
Urban Open	57.4	<1%
Transportation	295.6	3.2%
Waste Disposal	1.5	<1%
Water	429.8	4.7%
Powerline	28.7	<1%
Saltwater	7.0	<1%
Golf Course	98.5	1.1%
Marina	2.5	<1%
Urban Public	273.1	3%
Cemetery	83.1	<1%
Nursery	4.0	<1%
Forested Wetlands	588.8	6.4%
Junkyard	4.6	<1%
Brushland/Successional	15.7	<1%
<b>Total Acres</b>	<b>9230.6</b>	<b>100.0%</b>

For more information on how the land use statistics were developed and the definitions of the categories, please go to <https://docs.digital.mass.gov/dataset/massgis-data-land-use-2005>.

#### Economic Elements

Since the 1980's commercial and retail activity have expanded and replaced many earlier industrial activities. Town staff identified transportation corridors where disruption from a hazardous event could cause an economic impact. These include the Granite Street corridor, where there is a significant presence of warehousing, manufacturing, office space, and commercial shopping centers. Another site identified was the intersection of Hancock and Washington Streets, which provides access to warehousing areas and is an

important commuter route (Route 37). Rail lines serving commuters and freight are also in this area. In the March 2010 flood, this intersection and the adjacent rail lines were flooded and the intersection was closed for several days. The Union Street rotary and intersection with Route 3 is another critical transportation node. Finally, Weymouth Landing is an important village center area with a commuter rail station that is subject to flooding from the Monaquot River.

## NATURAL, CULTURAL, AND HISTORIC RESOURCE AREAS

Braintree has a distinct historical district around the town center. The town center includes French's Common, the Town Hall, the Thayer Academy campus, the General Sylvanius Thayer House (now Home of the Historical Society), and the Water Department building (formerly the Town Library, built in 1874). Streetscape improvements undertaken in this area reinforce the historical character of the town center as does the Thayer Public Library.

## DEVELOPMENT TRENDS

Development trends throughout the metropolitan region are tracked by MassBuilds, MAPC's Development Database, which provides an inventory of new development over the last decade. The database tracks both completed developments and those currently under construction. The database includes six completed projects in the Town of Braintree since 2012.

The database also includes several attributes of the new development, including housing units, and commercial space. The six developments in Braintree include a total of 1,112 housing units and 119,790 square feet of commercial space.

**Table 30: Summary of Braintree Developments, 2012-2018**

Name	Status	Year	Housing Units	Commercial Square Feet	Project Type
Almquist Subdivision	Completed	2015	8		Residential
Jonathan's Landing	Completed	2016	318		Multifamily
The Landing Apartments	Completed	2017	172	11,000	Mixed Use
Residence Inn Braintree	Completed	2017		7,040	Commercial
529-535 Washington St	Planning	2018		1,750	Commercial
CATS Academy	In Construction	2018	614	100,000	Mixed Use

## POTENTIAL FUTURE DEVELOPMENT

MAPC consulted with the Local Hazard Mitigation Planning Team to determine areas that may be developed in the future, based on the Town's comprehensive planning efforts and current trends and projects. These areas are listed below with their flood risk outlined in Table 31. In order to characterize any change in the town's vulnerability associated with new developments, a GIS mapping analysis was conducted which overlaid the development sites with the FEMA Flood Insurance Rate Map. Potential future development projects:

- A) Adams Street along the Monatiquot River: potential redevelopment of contractor's buildings.
- B) 201 Commerce Drive: 41,000 square foot contractor's building

#### **FUTURE DEVELOPMENT IN HAZARD AREAS**

Table 31 shows the relationship between potential future development areas and two of the mapped hazards (flood zones and snowfall). This information is provided so that planners can ensure that development proposals comply with floodplain zoning and that careful attention is paid to drainage issues.

**Table 31: Relationship of Potential Development to Hazard Areas**

Map ID	Potential Future Project	Flood Zones
A	Adams Street	89% in AE zone
B	Commerce Drive	No

### **CRITICAL FACILITIES & INFRASTRUCTURE IN HAZARD AREAS**

Critical facilities and infrastructure includes facilities that are important for disaster response and evacuation (such as emergency operations centers, fire stations, water pump stations, communications, and electricity) and facilities where additional assistance might be needed during an emergency (such as nursing homes, elderly housing, day care centers, etc.). There are 88 facilities identified in Braintree. These are listed in Table 32 and are shown on the maps in Appendix B.

#### **Explanation of Columns in Table 32**

- **Column 1: ID #:** The first column in Table 32 is an ID number which appears on the maps that are part of this plan. See Appendix B.
- **Column 2: Name:** The second column is the name of the site.
- **Column 3: Type:** The third column indicates what type of site it is.
- **Column 4: FEMA Flood Zone:** The fourth column addresses the risk of flooding. A "No" entry in this column means that the site is not within any of the mapped risk zones on the Flood Insurance Rate Maps (FIRM maps). If there is an entry in this column, it indicates the type of flood zone. as follow s:  
**Zone AE** (1% annual chance) - Zones AE is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the FIS by detailed methods. Mandatory flood insurance purchase requirements apply.  
**Zone VE** (1% annual chance) - Zone VE is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone. Mandatory flood insurance purchase requirements apply.  
**Zone X** (.2% annual chance) - Zones X is the flood insurance rate zone that corresponds to the 500-year floodplains.
- **Column 5: Locally-Identified Area of Flooding:** The fifth column indicates the risk of flooding in local hazard areas. A "No" entry in this column means that the site is not within any of the mapped flood hazard zones. If there is an entry in this column, it indicates the local hazard area.
- **Column 6: Brush Fire Area:** The sixth column indicates the risk of brush fire in local hazard areas. A "No" entry in this column means that the site is not within any of the mapped brush fire hazard zones. If there is an entry in this column, it indicates the local hazard area.

**Table 32: Critical Facilities and Relationship to Hazard Areas**

<b>ID</b>	<b>Name</b>	<b>Type</b>	<b>FEMA Flood Zone</b>	<b>Locally Identified Flood Area</b>	<b>Brush Fire Risk</b>
1	Sewer Pump Station	Sewer Pump Station	AE: 1% Annual Chance	Crawford, Webb & Stevens	No
2	Sewer Pump Station	Sewer Pump Station	No	Braintree Highway Barn	No
3	St. Coletta's Day School	School	No	No	No
4	Ross Elementary School	School	No	No	No
5	Archbishop Williams High	School	No	No	No
7	South Shore Seventh Day Advent School	School	No	No	No
8	Pilgrim Center	School	No	Adams Street	No
9	Elihu White Nursing Home	Medical Facility	No	Allen Street	No
10	Mary E Flaherty School	School	No	No	No
11	Archie T Morrison School	School	No	Norfolk, Andrea, & Eileen	No
12	East Middle School - HLZ	Helipad	No	No	Hillside
13	East Middle School	School	No	No	Hillside
14	Sewer Pump Station	Sewer Pump Station	AE: 1% Annual Chance	West Street / Great Pond Dam	No
15	John Scott Nursing Home	Medical Facility	No	No	No
17	Hollis Elementary School	School	No	No	No
18	Sewer Pump Station	Sewer Pump Station	X: 0.2% Annual Chance	Barstow, off IDA	No
19	Morrison Elementary School	School	No	Norfolk, Andrea, & Eileen	No
20	Braintree Police Dept. HQ	Police Station	No	Braintree Highway Barn	No
21	Fire Station #2	Fire Station	No	No	South Braintree Park
22	Sewer Pump Station	Sewer Pump Station	X: 0.2% Annual Chance	Jefferson at Ellery Street	No
23	Sewer Pumping Station	Sewer Pump Station	No	Quincy & Howard	No
24	Sewer Pump Station	Sewer Pump Station	No	No	No
25	Thayer Public Library	Emergency Operations Center	No	No	No
26	Thayer Academy	School	No	No	No
27	Braintree Fire Dept. Hdq.	Fire Station	No	No	No

ID	Name	Type	FEMA Flood Zone	Locally Identified Flood Area	Brush Fire Risk
28	Braintree Town Hall	EOC	No	No	No
30	Electric Substation # 11	Utility	No	No	Smith Beach
31	St Francis Of Assisi	School	No	No	No
32	Braintree High	School	No	No	No
33	Electric Substation # 9	Utility	No	No	No
34	Health South	Medical Facility	No	No	No
35	Great Pond Water Supply	Water Treatment	No	No	No
36	Algonquin Gas Pipelines	Gas Pipeline	No	No	No
37	Braintree High - HLZ	Helipad	No	No	No
41	T Station	MBTA Station	No	Union Street	No
42	BELD	Light Plant	No	No	No
43	SEAMASS Transfer Station	Hazardous Material Site	No	No	No
47	Hollingsworth House	Medical Facility	No	No	No
48	Braintree Manor	Medical Facility	No	Hancock & Rote 37	No
53	Grove Manor Estates	Medical Facility	No	No	No
54	Water Storage Tank	Water Storage Tank	No	No	No
55	Logan Nursing and Rehab Center	Medical Facility	No	No	No
56	Braintree Parks Recreation Department	Parks	No	Watson Park	No
57	Logan Park Elder Housing	Elder Housing	No	No	No
59	Liberty Elementary School	School	No	No	No
60	Massasoit School Inc.	School	No	No	No
61	South Middle School	School	No	No	No
62	Highlands Elementary School	School	No	No	No
66	BELD	Power Plant	No	No	No
69	Fire Station # 3	Fire Station	No	No	No
72	Highland Medical Facility	Medical Facility	No	No	South Braintree Park
77	Old Quincy Reservoir (Braintree Dam)	Dam	AE: 1% Annual Chance	No	No
78	Eaton's Pond Dam	Dam	A: 1% Annual	No	No
79	Factory Pond Dam	Dam	AE: 1% Annual Chance	No	No

ID	Name	Type	FEMA Flood Zone	Locally Identified Flood Area	Brush Fire Risk
80	Smelt Brook Dam	Dam	X: 0.2% Annual Chance	No	Pond Meadow
87	B.A.S.E.	School	No	Lundquist, Granite & Campanelli	No
91	BELD site	Municipal	No	Allen Street	No
97	Independence Manor 1	Elder Housing	No	No	No
98	Independence Manor 2	Elder Housing	No	No	No
114	Braintree Medical Facility Center	Medical Facility	No	No	Blue Hills Reservation, off Route 128
130	Grove Manor Rear Building	Medical Facility	No	No	No
135	CATS Academy	School	No	No	South Street/Hospital
136	Roosevelt Elder Housing	Elder Housing	No	No	No
142	Marge Crispin Center	Elderly Services	No	Hancock & Rote 37	No
143	National Guard Armory	Armory	No	Braintree Highway Barn	No
144	Braintree Highway Dept.	DPW Barn	AE: 1% Annual Chance	Braintree Highway Barn	No
145	Braintree Sewer Dept. and Garage	DPW Barn	No	Braintree Highway Barn	No
147	Braintree Council on Aging	Elder Care	No	No	No
148	Heritage Lane Elder Housing	Elder Housing	No	No	No
151	Transmission Lines	Electric Line	AE: 1% Annual Chance	No	No
153	Citgo Pier	Pier/ fuel depot	VE: High Risk Coastal Area	No	No
154	Sewer Pump Station	Sewer Pump Station	No	No	No
158	Water Storage Tower	Water Supply	No	No	No
159	Water Storage Tower	Water Supply	No	No	No
160	Water Storage Tower	Water Supply	No	No	No
161	Water Storage Tower	Water Supply	No	No	Skyline Drive / Eaton's Pond Area
162	Electric Substation # 15	Utility	No	No	No
163	Electric Substation #17	Utility	No	No	No
164	Armstrong Dam	Dam	AE: Regulatory Floodway	Jefferson at Shepherd Street	No
166	Electric Substation # 8	Utility	No	No	No
167	Electric Substation # 4	Utility	No	No	No
168	Electric Substation # 10	Utility	AE: 1% Annual	No	No

ID	Name	Type	FEMA Flood Zone	Locally Identified Flood Area	Brush Fire Risk
			Chance		
169	Great Pond Dam	Dam	A: 1% Annual Chance	No	No
170	Great Pond Upper Reservoir Dam	Dam	A: 1% Annual Chance	No	No
174	Armstrong Pond Dam	Dam	AE: Regulatory Floodway	No	No
175	Smith's Beach	Recreation	VE: High Risk Coastal Area	No	Smith Beach
176	Sunset Lake Dam	Dam	No	No	No
177	Braintree Water and Sewer	Water and Sewer	No	Watson Park	No

## VULNERABILITY ASSESSMENT

The purpose of the vulnerability assessment is to estimate the extent of potential damages from natural hazards of varying types and intensities. A vulnerability assessment and estimation of damages was performed for hurricanes, earthquakes, and flooding through the HAZUS-MH software.

### Introduction to HAZUS-MH

HAZUS- MH (multiple-hazards) is a computer program developed by FEMA to estimate losses due to a variety of natural hazards. The following overview of HAZUS-MH is taken from the FEMA website. For more information on the HAZUS-MH software, go to <http://www.fema.gov/plan/prevent/hazus/index.shtm>

“HAZUS-MH is a nationally applicable standardized methodology and software program that contains models for estimating potential losses from earthquakes, floods, and hurricane winds. HAZUS-MH was developed by the Federal Emergency Management Agency (FEMA) under contract with the National Institute of Building Sciences (NIBS). Loss estimates produced by HAZUS-MH are based on current scientific and engineering knowledge of the effects of hurricane winds, floods and earthquakes. Estimating losses is essential to decision-making at all levels of government, providing a basis for developing and evaluating mitigation plans and policies as well as emergency preparedness, response and recovery planning.

HAZUS-MH uses state-of-the-art geographic information system (GIS) software to map and display hazard data and the results of damage and economic loss estimates for buildings and infrastructure. It also allows users to estimate the impacts of hurricane winds, floods and earthquakes on populations.”

There are three modules included with the HAZUS-MH software: hurricane wind, flooding, and earthquakes. There are also three levels at which HAZUS-MH can be run. Level 1 uses national baseline data and is the quickest way to begin the risk assessment process. The analysis that follows was completed

using Level 1 data. Level 1 relies upon default data on building types, utilities, transportation, etc. from national databases as well as census data. While the databases include a wealth of information on the Town of Braintree, it does not capture all relevant information. In fact, the HAZUS training manual notes that the default data is “subject to a great deal of uncertainty.”

However, for the purposes of this plan, the analysis is useful. This plan is attempting to generally indicate the possible extent of damages due to certain types of natural disasters and to allow for a comparison between different types of disasters. Therefore, this analysis should be considered to be a starting point for understanding potential damages from the hazards.

## ESTIMATED DAMAGES FROM HURRICANES

The HAZUS software was used to model potential damages to the community from a 100-year and 500-year hurricane event; storms that are 1% and 0.2% likely to happen in a given year, and roughly equivalent to a Category 2 and Category 4 hurricane. The damages caused by these hypothetical storms were modeled as if the storm track passed directly through the town, bringing the strongest winds and greatest damage potential.

Though there are no recorded instances of a hurricane equivalent to a 500-year storm passing through Massachusetts, this model was included in order to present a reasonable “worst case scenario” that would help planners and emergency personnel evaluate the impacts of storms that might be more likely in the future, as we enter into a period of more intense and frequent storms.

**Table 33: Estimated Damages from Hurricanes**

	Category 2	Category 4
<b>Building Characteristics</b>		
Estimated total number of buildings	11,000	
Estimated total building replacement value (2014 \$)	\$5,295,000,000	
<b>Building Damages</b>		
# of buildings sustaining minor damage	486	2,183
# of buildings sustaining moderate damage	25	333
# of buildings sustaining severe damage	1	26
# of buildings destroyed	0	16
<b>Population Needs</b>		
# of households displaced	20	155
# of people seeking public shelter	4	31
<b>Debris</b>		
Building debris generated (tons)	8,073	24,742
Tree debris generated (tons)	2,202	5,523
# of truckloads to clear building debris	104	435

<b>Value of Damages</b>		
Total property damage (buildings and content)	\$24,033.68	\$130,064.16
Total losses due to business interruption	\$1,793.52	\$13,033.85

## ESTIMATED DAMAGES FROM EARTHQUAKES

The HAZUS earthquake module allows users to define an earthquake magnitude and model the potential damages caused by that earthquake as if its epicenter had been at the geographic center of the study area. For the purposes of this plan, two earthquakes were selected: magnitude 5.0 and a magnitude 7.0. Historically, major earthquakes are rare in New England, though a magnitude 5 event occurred in 1963.

**Table 34: Estimated Damages from Earthquakes**

	Magnitude 5.0	Magnitude 7.0
Building Characteristics		
Estimated total number of buildings	11,000	
Estimated total building replacement value (2014 \$)	\$5,294,000,000	
Building Damages		
# of buildings sustaining slight damage	3,473	336
# of buildings sustaining moderate damage	1,915	2,337
# of buildings sustaining extensive damage	552	3,347
# of buildings completely damaged	144	5,907
Population Needs		
# of households displaced	636	8,233
# of people seeking public shelter	335	4,344
Debris		
Building debris generated (tons)	170,000	1,240,000
# of truckloads to clear debris (@ 25 tons/truck)	6,840	49,680
Value of Damages		
Total property damage	\$145,560,000	\$795,000,000
Total losses due to business interruption	\$700,760,400	\$5,041,980,000

## ESTIMATED DAMAGES FROM FLOODING

The HAZUS flooding module allows users model the potential damages caused by a 100-year flood event and a 500-year flood event.

**Table 35: Estimated Damages from Flooding**

	100-Year Flood	500-Year Flood
<b>Building Characteristics</b>		
Estimated total number of buildings	11,950	
Estimated total building replacement value (2014 \$)	\$5,295,000,000	
<b>Building Damages</b>		
# of buildings sustaining limited damage	92	107
# of buildings sustaining moderate damage	18	31
# of buildings sustaining extensive damage	3	3
# of buildings substantially damaged	0	0
<b>Population Needs</b>		
# of households displaced	281	338
# of people seeking public shelter	530	668
<b>Value of Damages</b>		
Total property damage	\$20,740,000	\$27,010,000
Total losses due to business interruption	\$350,000	\$440,000

# SECTION 5: HAZARD MITIGATION GOALS

The Braintree Local Hazard Mitigation Planning Team reviewed and discussed the goals from the 2012 Hazard Mitigation Plan for the Town of Braintree. All of the goals are considered critical for the Town and they are not listed in order of importance. Prior to the Hazard Mitigation Plan update process, the Town of Braintree developed a Climate Change Vulnerability Analysis and Action Plan. The local team chose to incorporate climate considerations as noted in Goal 11.

- GOAL 1:** Ensure that critical infrastructure sites are protected from natural hazards.
- GOAL 2:** Protect existing residential and business areas from flooding
- GOAL 3:** Maintain existing mitigation infrastructure in good condition.
- GOAL 4:** Continue to enforce existing zoning and building regulations.
- GOAL 5:** Educate the public about zoning and building regulations.
- GOAL 6:** Work with surrounding communities to ensure regional cooperation and solutions for hazards affecting multiple communities.
- GOAL 7:** Encourage future development and redevelopment in areas that are not prone to natural hazards.
- GOAL 8:** Educate the public about natural hazards and mitigation measures.
- GOAL 9:** Make efficient use of public funds for hazard mitigation.
- GOAL 10:** Pursue land acquisition strategies.
- GOAL 11:** Consider the potential impacts of future climate change. Incorporate climate sustainability and resiliency in hazard mitigation planning.

## SECTION 6: EXISTING MITIGATION MEASURES

The existing protections in the Town of Braintree are a combination of zoning, land use, and environmental regulations, infrastructure maintenance, and drainage infrastructure improvement projects. Infrastructure maintenance generally addresses localized drainage clogging problems, while large scale capacity problems may require pipe replacement or invert elevation modifications. These more expensive projects are subject to the capital budget process and lack of funding is one of the biggest obstacles to completion of some of these. Braintree's adoption of a stormwater utility will contribute significantly to efforts to address stormwater flooding.

The Town's existing mitigation measures, which were in place prior to the original 2005 Plan, are listed by hazard type here and are summarized in Table 36 below. Many upgrades to existing measures are noted in the following sections.

### EXISTING TOWN-WIDE MITIGATION FOR FLOOD-RELATED HAZARDS

Braintree employs a number of practices to help minimize potential flooding and impacts from flooding, and to maintain existing drainage infrastructure. Existing town-wide mitigation measures include the following:

*Participation in the National Flood Insurance Program (NFIP)* – Braintree participates in the NFIP with 240 policies in force as of the September 30, 2018. FEMA maintains a database on flood insurance policies and claims. This database can be found on the FEMA website at <https://www.fema.gov/policy-claim-statistics-flood-insurance>.

The following information is provided for the Town of Braintree:

Flood insurance policies in force (September 30, 2018)	240
Coverage amount of flood insurance policies	\$64,792,600
Premiums paid	\$295,496
Total losses (all losses submitted regardless of the status)	164
Closed losses (losses that have been paid)	137
Open losses (losses that have not been paid in full)	0
CWOP losses (losses that have been closed without payment)	27
Total payments (total amount paid on losses)	\$2,020,520.53

The Town complies with the NFIP by enforcing floodplain regulations, maintaining up-to-date floodplain maps, and providing information to property owners and builders regarding floodplains and building requirements.

*CRS Program Participation* – The Town of Braintree participates in the Community Rating System (CRS) program, gaining a reduction in flood insurance rates for property owners in the Town in exchange for mitigation actions taken to reduce the Town's potential vulnerability to flooding. The program functions on a rating system, with an individual community's rating being based on the number of points they receive,

with points allocated for each flood mitigation measure enacted. The Town of Braintree currently has a rating of Class 7, resulting in a 15% reduction in flood insurance rates in the Town.

*Public Works Operations/Maintenance Activities* – The Public Works Department actively maintains the Town’s storm drain system. The following specific activities serve to maintain the capability of the drainage system through the reduction of sediment and litter build up and proper maintenance and repair.

- o *Street sweeping* – All streets are swept three times a year.
- o *Catch basin cleaning* – All are cleaned once every two to three years.
- o *Roadway treatments* – Streets are treated with a mix of sand, salt, and liquid brine applicator.

*Town of Braintree Master Plan* – While it is much broader-based and focuses on all aspects of development in the Town, issues that touch on flooding and hazard mitigation can be found throughout the plan. The plan focuses more on policies and strategies than on detailed recommendations.

*Conservation/Recreation Open Space Plan* – A new draft Open Space and Recreation Plan has just been completed. The plan identifies a number of open space parcels and actions to improve environmental quality, which could also benefit hazard mitigation efforts.

*Floodplain Zoning District* – Zoning is intended to protect the public health and safety through the regulation of land use. The Braintree Zoning Bylaw includes a Wetlands and Floodplain District (Article VI, Section 135-608). The purposes of this district are:

1. Protect the health and safety of persons and property against one-hundred-year frequency flooding and the hazard of water inundation;
2. Control one-hundred-year-frequency flooding and regulate the development of land and the construction of buildings and structures within the district;
3. Preserve and maintain the groundwater table. Since these areas contribute to the natural storage of water during times of maximum rainfall, it is intended that the areas be controlled and conserved in as near their present state as possible, and that any change therein as herein provided shall not substantially affect surface or ground water levels nor jeopardize the public health or safety nor derogate from the intent and purpose of this district.

*Wetlands and Floodplain District* - is an overlay district, corresponding to the 100 year floodplain as defined by the most recent Flood Insurance Study and Flood Insurance Rate Map (FIRM). In addition, the Town allows for the application of this district to areas where there is a recorded observation of flooding. Within the District, no building or structure shall be constructed, improved, altered or modified and no land shall be filled, excavated or otherwise changed in grade except pursuant to a special permit authorized by the Braintree Planning Board. Further, no critical facility, defined as facilities handling hazardous materials, hospitals, nursing homes, and buildings used for the storage of important documents may be located in this district.

A proposed project in the Wetlands and Floodplain District must meet the following standards in order to be granted a special permit:

1. The proposed construction and/or change in grade will not derogate from the intent and purpose of the Wetlands and Floodplain District;
2. The proposed construction and/or change in grade will not endanger the health and safety of the public;
3. The lowest floor, including the basement or cellar, of any new or substantially improved residential building shall be at least one foot above the base flood elevation;
4. Nonresidential construction or improvements shall be elevated or flood proofed to one foot above the base flood elevation;
5. The proposed construction and/or change in grade shall not:
  - a. Obstruct or divert flood flow;

- b. Reduce natural storage or increase stormwater runoff to the extent of raising the base flood elevation. Written certification of such shall be provided by a registered professional engineer;
6. The proposed system of drainage and sewage disposal shall not cause pollution or otherwise endanger public health;
7. The proposed structures shall be constructed to counteract any buoyancy or water impacts;
8. The proposed construction shall have street or other appropriate access at least one foot above the base flood elevation. In addition, all development activity in the District must meet all other applicable codes and regulations.

*Cluster Zoning* – The Town of Braintree has provisions in the Zoning Bylaw allowing for cluster development (Article VI, section 135-610). Amongst other purposes listed, the Town has identified cluster zoning as a means of protecting water bodies and water supplies, wetlands, and floodplains.

*Wetland Bylaw* – The purpose of the Wetland Bylaw (Chapter 12.20) is to further protect the Town's wetlands, water resources, groundwater quality, and adjoining areas for, among other reasons, flood control, storm damage prevention, and erosion and sedimentation control. The bylaw requires review of all development, excavation, or fill activities in or within 100 feet of any wetland, shoreline, coastal feature, also any land subject to tidal action, coastal storm flowage, or flooding.

*Public Education* – The Flood Hazard Mitigation Division of the Braintree Planning and Community Development Department provides a great deal of information on flood mitigation techniques for residents and business owners on their website. The Fire Department and Department of Public Works also provide some information on fire safety and snow hazards, respectively, on their websites.

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## **EXISTING DAM FAILURE MITIGATION MEASURES**

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*Permits required for construction* – State law requires a permit for the construction of any dam.

*DCR dam safety regulations* – All dams are subject to the Division of Conservation and Recreation's dam safety regulations.

*Dam Maintenance* – The Water and Sewer Department is responsible for inspecting and maintaining several publicly owned dams in the Town. The Highway Department maintains the embankments of the Braintree and Eaton's Pond Dams.

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## **EXISTING TOWN-WIDE MITIGATION FOR WIND-RELATED HAZARDS**

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*Massachusetts State Building Code* – The town enforces the Massachusetts State Building Code whose provisions are generally adequate to protect against most wind damage. The code's provisions are the most cost-effective mitigation measure against tornados given the extremely low probability of occurrence. If a tornado were to occur, the potential for severe damages would be extremely high.

*Tree-trimming program* – The Town and the Braintree Electric Light Department, supplemented by a private tree contractor, conduct tree maintenance on public property. The Town has equipment to trim and remove trees as needed.

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## **EXISTING TOWN-WIDE MITIGATION FOR WINTER-RELATED HAZARDS**

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*Snow disposal* – The Town conducts general snow removal operations with its own equipment. Where necessary, snow is removed and dumped on other Town properties. The Town has four designated snow dumping locations.

*Development Review* – Where possible, the Town includes conditions on development proposals relative to snow removal and storage.

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## EXISTING TOWN-WIDE MITIGATION FOR FIRE-RELATED HAZARDS

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*Burn Permits* – The Braintree Fire Department follows the State guidelines for outdoor burning. Outdoor burn season is from January 15 through May 1 and a permit is required.

*Subdivision/Development Review* – The Fire Department is involved in all development project reviews.

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## EXISTING TOWN-WIDE MITIGATION FOR EARTHQUAKE HAZARDS

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*Massachusetts State Building Code* – The State Building Code contains a section on designing for earthquake loads (780 CMR 1612.0). Section 1612.1 states that the purpose of these provisions is “to minimize the hazard to life to occupants of all buildings and non-building structures, to increase the expected performance of higher occupancy structures as compared to ordinary structures, and to improve the capability of essential facilities to function during and after an earthquake”. This section goes on to state that due to the complexity of seismic design, the criteria presented are the minimum considered to be “prudent and economically justified” for the protection of life safety. The code also states that absolute safety and prevention of damage, even in an earthquake event with a reasonable probability of occurrence, cannot be achieved economically for most buildings.

Section 1612.2.5 sets up seismic hazard exposure groups and assigns all buildings to one of these groups according to Table 1612.2.5. Group II includes buildings which have a substantial public hazard due to occupancy or use and Group III are those buildings having essential facilities which are required for post-earthquake recovery, including fire, rescue and police stations, emergency rooms, power-generating facilities, and communications facilities.

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## EXISTING TOWN-WIDE MITIGATION FOR LANDSLIDE HAZARDS

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*Zoning* – Grading regulations in the zoning bylaw include maximum slopes requirements and erosion and sediment controls.

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## EXISTING MULTI-HAZARD MITIGATION MEASURES

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*Comprehensive Emergency Management Plan (CEMP)* – Every community in Massachusetts is required to have a Comprehensive Emergency Management Plan. These plans address mitigation, preparedness, response and recovery from a variety of natural and man-made emergencies. These plans contain important information regarding flooding, hurricanes, tornadoes, dam failures, earthquakes, and winter storms. Therefore, the CEMP is a mitigation measure that is relevant to all of the hazards discussed in this plan.

*Communications Equipment* – Braintree has full coverage of the Town with emergency services radio and the Braintree Electric Light Department (BELD) allows residents to enroll in a “Rapid Alert” system that calls and/or emails residents in case of an emergency. The Town also has a reverse 911 system. Incident command units are available through Norfolk County and MEMA.

*Emergency Power Generators* – The Town maintains emergency power generators in several important public facilities and emergency shelters. These include Braintree Fire Stations #2 and #3, the DPW Barn, Emergency Management, Braintree High School, East Middle School, and South Middle School.

*Massachusetts State Building Code* – The Massachusetts State Building Code contains many detailed regulations regarding wind loads, earthquake resistant design, flood-proofing, and snow loads.

*Local Emergency Management Planning Committee (LEPC)* – The Fire Department leads the LEPC, which meets on a quarterly or as-needed basis.

## COMPILATION OF EXISTING MITIGATION

Table 36 summarizes the many existing natural hazard mitigation measures already in place in Braintree when the first Hazard Mitigation Plan was adopted in 2005. Because of the number of entities, public and private, involved in natural hazard mitigation, it is likely that this list is a starting point for a more comprehensive inventory of all measures.

**Table 36: Existing Natural Hazard Mitigation Measures in Braintree**

Type of Existing Mitigation Measure	Effective	Improvements/Changes Needed
<b>FLOOD HAZARDS</b>		
Participation in the National Flood Insurance Program	Yes	
CRS Program Participation	Yes	
Public Works Operations/Maintenance Activities	Yes	
Master Plan	Yes	The Town plans to update the Master Plan in coming years.
Open Space and Recreation Plan	Yes	A full draft of the updated plan has been completed.
Floodplain Zoning District	Yes	The Floodplain Zoning District will be updated as part of the current zoning review process.
Cluster zoning	Yes	Cluster Zoning will be updated as part of the current zoning review process.
Wetlands Bylaw	Yes	
Public Education	Yes	Use social media to increase public education.
<b>DAM HAZARDS</b>		
Permits required for construction	Yes	
Dam safety regulations	Yes	
DCR Maintenance	Yes	
<b>WIND HAZARDS</b>		
Mass State Building Code	Yes	
Tree Trimming Program	Yes	
<b>WINTER HAZARDS</b>		
Snow Disposal Site	Yes	An additional site is needed.
Development Review	Yes	
<b>FIRE HAZARDS</b>		
Open burning permits required	Yes	
Subdivision/Development Review	Yes	
<b>EARTHQUAKE HAZARDS</b>		

Type of Existing Mitigation Measure	Effective	Improvements/Changes Needed
Mass State Building Code	Yes	
<b>LANDSLIDE HAZARDS</b>		
Grading requirements in the zoning bylaw include maximum slope requirements and erosion and sediment controls.	Yes	
<b>MULTI-HAZARDS</b>		
Comprehensive Emergency Management Plan (CEMP)	Yes	The CEMP is in the process of being updated
Communications Equipment	Yes	All communications equipment is in the process of being updated and integrated across town departments.
Emergency Power Generators	Yes	Police and all fire locations now have generators and portable generators are available.
Massachusetts State Building Code	Yes	
Local Emergency Planning Committee	Yes	

## MITIGATION CAPABILITIES AND LOCAL CAPACITY FOR IMPLEMENTATION

Under the Massachusetts system of “Home Rule,” the Town of Braintree is authorized to adopt and from time to time amend local bylaws and regulations that support the town’s capabilities to mitigate natural hazards. These include Zoning Bylaws, Subdivision and Site Plan Review Regulations, Wetlands Bylaws, Health Regulations, Public Works regulations, and local enforcement of the State Building Code. Local Bylaws may be amended by Town Council to improve the town’s capabilities, and changes to most regulations simply require a public hearing and a vote of the authorized board or commission.

The Town of Braintree has recognized several existing mitigation measures that require implementation or improvements, and has the capacity within its local boards and departments to address these. The Town’s Planning Department is leading a comprehensive zoning bylaw review. The Mayor’s office will coordinate social media upgrades.

# SECTION 7: MITIGATION MEASURES FROM PREVIOUS PLAN

## IMPLEMENTATION PROGRESS ON THE PREVIOUS PLAN

At a meeting of the Braintree Hazard Mitigation Planning Committee, Town staff reviewed the mitigation measures identified in the 2012 Braintree Hazard Mitigation Plan and determined whether each measure had been implemented or deferred. Of those measures that had been deferred, the committee evaluated whether the measure should be deleted or carried forward into this Hazard Mitigation Plan 2019 Update. The decision on whether to delete or retain a particular measure was based on the committee's assessment of the continued relevance or effectiveness of the measure and whether the deferral of action on the measure was due to the inability of the Town to take action on the measure. Table 37 summarizes the status of mitigation measures from the 2012 plan.

**Table 37: Mitigation Measures from the 2012 Plan**

Mitigation Measure	Priority in 2012 Plan	Current Status	Include in 2019 Plan?
Flood Mitigation			
Dickerman Lane and Staten Road Project	High	This project was successfully completed.	N
Monatiquot River Watershed Management Plan	High	Students from the UMass Planning and Landscape Architecture program completed the plan in 2011.	N
Great Pond Dam	High	Significant mitigation work was completed. There are remaining infiltration issues that need to be addressed.	Y
West Street / Pond Street Roadway Elevation	High	The roadway elevation project was not implemented. However, the Town replaced the undersized culvert in 2006 with a larger culvert that has reduced flooding in this area. Much of the roadway is below the Base Flood Elevation and elevation may be evaluated in the future though it is a low priority.	Y
Water Elevation Control	High	The Town is addressing this issue by moving forward with plans to remove the Armstrong Dam which will provide flood mitigation.	N
Regional Vacuum Truck	High	The Water and Sewer, and Public Works Departments purchased vacuum trucks.	N
Repetitive Loss Area Property Owner Outreach	High	The town does regular outreach to repetitive loss property owners as part of its participation in the Community Rating System program. This is an ongoing priority.	Y
Bestick Road Area	High	This project was determined to be unnecessary because of the	N

<b>Mitigation Measure</b>	<b>Priority in 2012 Plan</b>	<b>Current Status</b>	<b>Include in 2019 Plan?</b>
Flood Control		mitigation work completed at Dickerman Lane and Staten Road.	
Braintree Highway Department Barn	High	This project has not been completed. Relocation of the Highway Barn is both a high priority and a high cost project.	Y
Enhance Drainage at Union Street	High	Drainage has been enhanced, primarily through dredging done by Mass DOT. However, road flooding is still an issue in this location.	Y
Promote Low Impact Development Techniques	High	The town regularly encourages LID through the Planning Board and Conservation Commission. The new Stormwater Division within Public Works will increase focus on LID techniques as part of compliance with the federal MS4 permit. This is an ongoing priority.	Y
CRS Program Maintenance	Medium	Through its flood mitigation efforts, the Town improved its rating in the CRS program. As a result flood insurance discounts for residents have increased from 5% to 15%. This is an ongoing priority.	Y
Reduce Impervious Area	Medium	The town addresses this issue through Site Plan Review and the Wetlands Protection Act. The new Stormwater Division within Public Works will increase focus on reducing impervious surfaces as part of compliance with the federal MS4 permit. This is an ongoing priority.	Y
Map Storm Drain System	Medium	The town has completed significant mapping of the stormwater system, however this is an increasing priority in order to ensure compliance with the MS4 permit.	Y
Restore Riverfronts	Medium	Property has been acquired along the Monaquot River. A portion of the Smelt Brook was daylighted. The town has received grant funding for a current project to stabilize eroding shoreline along the Fore River. The Town encourages any redevelopment projects along the rivers to include restoration. This is an ongoing priority.	Y
Pump Station Back-up Generators	Medium	All pump stations either have a back-up or are bypassed.	N
Public Education, Flooding	High	The town does significant public education, particularly through participation in the CRS program. The new Stormwater Division is also providing significant public education. This is an ongoing priority.	Y
Floodplain Management	High	The Floodplain Zoning District is being updated as part of the ongoing Comprehensive Zoning Project.	Y
Floodplain Mapping	High	The town maintains up-to-date FEMA floodplain maps. The town does this as part of NFIP compliance as noted in Table 36.	N

<b>Mitigation Measure</b>	<b>Priority in 2012 Plan</b>	<b>Current Status</b>	<b>Include in 2019 Plan?</b>
Acquisition of Vacant Flood Prone Lands	Medium	The town purchased a six-acre property on Middle Street in 2018. A portion of the property is within the 100 year floodplain of the Monatiquot River. Acquisition is an ongoing priority however much of the land within the floodplain is either already owned by the Town or developed. There is very little land which is both undeveloped and unprotected in the floodplain.	Y
Geologic Mitigation			
Municipal Building Assessment	Low	This project was not implemented.	Y
Fire Mitigation			
Brushfire Control Access Study	Low	This project was not implemented.	Y
Multi-Hazard Mitigation			
Emergency Power Generators	High	Many generators have been purchased and upgraded. However, this is an ongoing need for the Town.	Y

As indicated in Table 37, Braintree made significant progress implementing mitigation measures identified in the 2012 Hazard Mitigation Plan. Many flood protection projects have been completed. Infrastructure projects include: the drainage projects at Dickerman Lane and Staten Road; dredging at Union Street; improvements to Great Pond Dam; and ensuring back-up or bypass for all stormwater pump stations. Other achievements include: increasing the Town's CRS rating from Class 9 to Class 7, acquiring property along the Monatiquot River and daylighting a portion of Smelt Brook, purchasing two vacuum trucks, grant funding for a project to stabilize eroding shoreline on the Fore River, and completing a study of the Monatiquot River, and of Armstrong Dam removal.

Policy, programmatic areas, and plans that incorporated hazard mitigation priority achievements include: the Climate Vulnerability Assessment Plan, the Comprehensive Zoning Update Project, the Community Rating System Program, the new Stormwater Utility and Stormwater Division, Planning Board and Conservation Commission review, the Community Preservation Act and Committee, and the Armstrong Dam Removal Feasibility Study.

Several projects that were not completed will be continued into this plan update. A top priority, and a significant cost, is relocation of the Public Works Highway Barn. Locations where flooding was reduced but additional work is still needed include Great Pond Dam, Union Street, and West Street. Other projects include detailed mapping of the Town's stormwater system, assessment of municipal buildings for earthquake hazards, and minor update to the Floodplain Zoning District.

There are a number of measures for which the Town does regular work, but they remain ongoing priorities. These include: outreach to repetitive loss property owners, promoting low impact development, maintaining participation in the CRS program, reducing impervious surfaces, restoring riverfront areas, acquisition of flood-prone land, purchase of generators, and public education. An additional significant achievement for the Town was the establishment of funding for a Stormwater Utility. This has significantly increased the resources available to address stormwater flooding.

Overall, fourteen mitigation measures from the 2012 plan will be continued in the plan update. Most retain the same priority in this 2019 update. Eight of these are ongoing projects as noted above. The mitigation measure regarding the Armstrong Dam will not be carried forward as the Town is proceeding with plans to remove the dam. Moving forward into the next five year plan implementation period there will be many more opportunities to incorporate hazard mitigation into the Town's decision making processes. The challenges the Town faces in implementing these measures are primarily due to limited funding and available staff time. This plan should help the Town prioritize the best use of its limited resources for enhanced mitigation of natural hazards.

# SECTION 8: HAZARD MITIGATION STRATEGY

## WHAT IS HAZARD MITIGATION?

Hazard mitigation means to permanently reduce or alleviate the losses of life, injuries and property resulting from natural hazards through long-term strategies. These long-term strategies include planning, policy changes, education programs, infrastructure projects and other activities. FEMA currently has three mitigation grant programs: the Hazards Mitigation Grant Program (HGMP), the Pre-Disaster Mitigation program (PDM), and the Flood Mitigation Assistance (FMA) program. The three links below provide additional information on these programs.

<https://www.fema.gov/hazard-mitigation-grant-program>

<https://www.fema.gov/pre-disaster-mitigation-grant-program>

<https://www.fema.gov/flood-mitigation-assistance-grant-program>

Hazard Mitigation Measures can generally be sorted into the following groups:

- **Prevention:** Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built. These actions also include public activities to reduce hazard losses. Examples include planning and zoning, building codes, capital improvement programs, open space preservation, and stormwater management regulations.
- **Property Protection:** Actions that involve the modification of existing buildings or infrastructure to protect them from a hazard or removal from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, flood proofing, storm shutters, and shatter resistant glass.
- **Public Education & Awareness:** Actions to inform and educate citizens, elected officials, and property owners about the potential risks from hazards and potential ways to mitigate them. Such actions include outreach projects, real estate disclosure, hazard information centers, and school-age and adult education programs.
- **Natural Resource Protection:** Actions that, in addition to minimizing hazard losses also preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
- **Structural Projects:** Actions that involve the construction of structures to reduce the impact of a hazard. Such structures include storm water controls (e.g., culverts), floodwalls, seawalls, retaining walls, and safe rooms.
- **Emergency Services Protection:** Actions that will protect emergency services before, during, and immediately after an occurrence. Examples of these actions include protection of warning system capability, protection of critical facilities, and protection of emergency response infrastructure.

(Source: FEMA Local Multi-Hazard Mitigation Planning Guidance)

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## REGIONAL AND INTER-COMMUNITY CONSIDERATIONS

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Some hazard mitigation issues are strictly local. The problem originates primarily within the municipality and can be solved at the municipal level. Other issues are inter-community and require cooperation between two or more municipalities. There is a third level of mitigation which is regional and may involve a state, regional or federal agency or three or more municipalities.

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### REGIONAL PARTNERS

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In densely developed urban communities such as the metropolitan Boston area, mitigating natural hazards, particularly flooding, is more than a local issue. The drainage systems that serve these communities are complex systems of storm drains, roadway drainage structures, pump stations and other facilities owned and operated by a wide array of agencies including the Town, the Department of Conservation and Recreation (DCR), the Massachusetts Water Resources Authority (MWRA), Massachusetts Department of Transportation (MassDOT) and the Massachusetts Bay Transportation Authority (MBTA). The planning, construction, operation and maintenance of these structures are integral to the flood hazard mitigation efforts of communities. These agencies must be considered the communities' regional partners in hazard mitigation. These agencies also operate under the same constraints as communities do including budgetary and staffing constraints and they must make decisions about numerous competing priorities.

Following, is a brief overview of regional facilities found in Braintree and a discussion of inter-municipal issues.

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### OVERVIEW OF REGIONAL FACILITIES WITHIN BRAINTREE

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Major facilities owned, operated and maintained by state or regional entities include:

- Interstate I-93 (MassDOT)
- State Routes 3 and 37 (MassDOT)
- MBTA Commuter Rail Lines (3) (MBTA)
- MBTA Red Line (MBTA)
- Water supply Randolph/Holbrook/Braintree (Tri-Town Water Board)
- Blue Hills Reservation (Mass DCR)
- Pond Meadow Park (Braintree/Weymouth)

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### INTER-COMMUNITY CONSIDERATIONS

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Mitigation measures for the following regional issues should be taken into account as Braintree develops its own local plan:

A) Coordinate and Review Developments on a Regional Basis

As Braintree and the surrounding communities are undergoing development, it is vital that these communities communicate and provide input during the review processes. When addressing housing, transportation, and economic development projects, the impacts to neighbors must be addressed.

B) Fore River Watershed

Stormwater management and flooding are concerns that cross town lines and need attention at the watershed level.

C) Tri-Town Water Supply

Braintree, Holbrook, and Randolph share water supply and management. Flooding and drought are key concerns that effect water supply.

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## NEW DEVELOPMENT AND INFRASTRUCTURE

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As part of the process of developing recommendations for new mitigation measures for this plan update, the Town considered the issues related to new development, redevelopment, and infrastructure needs in order limit future risks. Taking into consideration the ongoing Comprehensive Bylaw Review, the Wetlands Act and bylaw enforced by the Conservation Commission, and the recent adoption of a Stormwater Utility, the town determined that existing regulatory measures are taking good advantage of local Home Rule land use regulatory authority to minimize natural hazard impacts of development. Priorities for the future include completion of the bylaw review.

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## PROCESS FOR SETTING PRIORITIES FOR MITIGATION MEASURES

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The last step in developing the Town's mitigation strategy is to assign a level of priority to each mitigation measure so as to guide the focus of the Town's limited resources towards those actions with the greatest potential benefit. At this stage in the process, the Local Hazard Mitigation Planning Team had limited access to detailed analyses of the cost and benefits of any given mitigation measure, so prioritization is based on the local team members' understanding of existing and potential hazard impacts and an approximate sense of the costs associated with pursuing any given mitigation measure.

Priority setting was based on local knowledge of the hazard areas, including impacts of hazard events, the extent of the area impacted, and the relation of a given mitigation measure to the Town's goals. In addition, the local Hazard Mitigation Planning Team also took into consideration factors such as the number of homes and businesses affected, whether or not road closures occurred and what impact closures had on delivery of emergency services and the local economy, anticipated project costs, whether any environmental constraints existed, and whether the Town would be able to justify the costs relative to the anticipated benefits.

Table 38 below demonstrates the prioritization of the Town's potential hazard mitigation measures. For each mitigation measure, the geographic extent of the potential benefiting area is identified as is an estimate of the overall benefit and cost of the measures. The benefits, costs, and overall priority were evaluated in terms of:

Estimated Benefits	
High	Action will result in a significant reduction of hazard risk to people and/or property from a hazard event
Medium	Action will likely result in a moderate reduction of hazard risk to people and/or property from a hazard event
Low	Action will result in a low reduction of hazard risk to people and/or property from a hazard event

Estimated Costs	
High	Estimated costs greater than \$100,000
Medium	Estimated costs between \$10,000 to \$100,000
Low	Estimated costs less than \$10,000 and/or staff time
Priority	
High	Action very likely to have political and public support and necessary maintenance can occur following the project, and the costs seem reasonable considering likely benefits from the measure
Medium	Action may have political and public support and necessary maintenance has potential to occur following the project
Low	Not clear if action has political and public support and not certain that necessary maintenance can occur following the project

**Table 38: Mitigation Measures Prioritization**

Mitigation Action	Geographic Coverage	Estimated Benefit (H/M/L)	Estimated Cost (H/M/L)	Priority
<b>FLOOD (Inland, Coastal, Stormwater, Dams)</b>				
Complete upgrade of Great Pond Dam	Site specific	High	Medium	Medium
West Street / Pond Street Roadway Flooding Elevation Assessment	Site specific	Low	High	Low
Repetitive Loss Area Property Owner Outreach	Town-wide	High	Low	High
Relocate Braintree Highway Department Barn	Site specific	High	High	High
Enhance Drainage at Union Street and Route 3	Site specific	High	High	Medium
Promote Low Impact Development Techniques and Encourage Reduction of Impervious Pavement	Town-wide	High	Low	Medium
Continue Participation in CRS Program	Town-wide	High	Low	Medium
Map Storm Drain System	Town-wide	High	High	High
Restore Riverfront and Floodplain to Natural Conditions	Site specific	Medium	High	High
Continue Public Education on Flood Mitigation	Town-wide	High	Low	High
Continue to enforce the Floodplain Zoning District Requirements	In District	High	Low	High
Acquire Vacant Flood Prone Lands	Site specific	High	High	Medium
Update Rainfall Rates in Stormwater and Wetlands Bylaws	Town-wide	High	Low	High
<b>BRUSHFIRE</b>				
Acquire Brushfire Truck	Wooded properties	High	High	High
<b>WIND (Hurricanes, Tornadoes, Nor'easters, Severe Thunderstorms)</b>				
Replace Elementary School Roofs with Wind Resistant Materials	Site specific	High	High	High

Mitigation Action	Geographic Coverage	Estimated Benefit (H/M/L)	Estimated Cost (H/M/L)	Priority
<b>DROUGHT</b>				
Develop Opportunities for Additional Surface Water Storage.	Site specific	High	High	High
<b>EARTHQUAKE</b>				
Municipal building assessment	Site specific	Low	Low	Low
<b>LANDSLIDE</b>				
Identify areas of potential landslide risk.	Town-wide	Low	Low	Low
<b>EXTREME HEAT AND COLD</b>				
Increase availability of battery storage.	Site specific	High	High	Medium
Upgrade emergency shelter.	Site specific	High	High	High
<b>WINTER STORMS</b>				
Purchase sidewalk plows.	Town-wide	High	High	High
Public education on frozen pipe risk.	Town-wide	High	Low	Medium
<b>MULTIHAZARDS</b>				
Upgrade emergency generators.	Site specific	High	High	High
Upgrade social media outreach and education	Town-wide	High	Low	Medium

## DESCRIPTION OF MITIGATION MEASURES

### ***Flooding***

**Complete Upgrade of Great Pond Dam:** The Town made significant improvements to the dam in the past five years. However, there are continuing issues with infiltration. Addressing the remaining work will result in an upgrade of the status of the dam from “fair” to “good”.

**West Street/Pond Street:** The Town enlarged a culvert in 2006 and believes that this has addressed much of the flooding. The Town will continue to monitor flooding and assess options for, and the necessity of, road elevation.

**Repetitive Loss Area Property Owner Outreach:** As part of the town’s participation in FEMA’s CRS program, Braintree does annual outreach to repetitive loss areas.

**Relocate Braintree Highway Barn:** The highway barn is frequently flooded in large storm events. Relocating the barn is a high priority for the town. In addition to eliminating damage to the barn, relocation would have the benefit of providing additional flood storage as well as environmental, scenic and recreational benefits, including restoration of a vegetated buffer to the Monatiquot River.

**Enhance drainage at Union Street at Route 3:** This is a chronic flooding area during heavy rainstorms and Union Street is a critical pathway for emergency evacuation and response. Much of the area is under the control of MassDOT. The town will engage with the state regarding drainage solutions.

**Promote Low Impact Development Techniques (LID) and Encourage Reduction of Impervious Pavement:** The town will continue to promote LID through its various regulatory and stormwater review processes. As much of the flooding in Braintree is the result of the rapid drainage of stormwater from impervious surfaces, to

the extent that LID techniques can lead to less impervious area and reduced runoff, these practices can also help to address flooding issues.

**Continue Participation in CRS Program:** Continue active participation in the Community Rating System program including regular public education events related to flood awareness and prevention as well as the availability of flood insurance through NFIP.

**Map Storm Drain System:** Building on the mapping already completed, the town will add detailed information included inverts, and condition, size, and type of pipes.

**Continue Public Education on Flood Mitigation:** Continue active public education programs related to flood and hurricane awareness and mitigation measures. In particular, information on strategies property owners can adopt to mitigate the impact of flooding on their homes or businesses should be provided to those in repetitive loss areas, floodplains, and areas with high water tables.

**Continue to enforce the Floodplain Zoning District Requirements:** Update as part of comprehensive zoning project and continue enforcement of the Floodplain Zoning District (Article VI, Section 135-608) and associated building regulations for floodplain areas.

**Acquire Vacant Flood Prone Lands:** Acquire priority open space parcels in floodplain areas as they become available, in order to maintain flood storage and water infiltration capacity.

**Update Rainfall Rates in Stormwater and Wetlands Bylaws:** Update the 10-year, 24-hour stormwater requirements from TP-40, to NOAA 14 or Northeast Regional Climate Center standards.

### **Brushfire**

**Acquire Brushfire Truck:** Acquire brushfire truck for difficult to access wooded areas subject to fire hazards.

### **Wind**

**Replace Elementary School Roofs with Wind Resistant Materials:** Protect the schools from storm damage by upgrading roofs with wind resistant materials.

### **Drought**

**Develop Opportunities for Additional Surface Water Storage:** Pursue opportunities to add water sources; obtain DEP approval for additional water sources, and pursue dredging the Richardi and Great Pond Reservoirs.

### **Earthquake**

**Municipal building assessment:** Investigate options to make all public municipal buildings earthquake resistant.

### **Landslide**

**Identify areas of potential landslide risk:** Do an assessment of locations that may have unstable slopes.

### **Extreme Temperatures**

**Increase availability of battery storage:** Pursue grant opportunities for additional battery storage to maintain power in the event of outages.

**Upgrade emergency shelter:** Upgrade plumbing at the Doherty Gym shelter to provide shower capacity.

### **Winter Storms**

**Purchase sidewalk plows:** Improve pedestrian safety with purchase of sidewalk plows.

**Public education on frozen pipe risk:** Do outreach to the public on how to manage and avoid frozen pipes.

### **Multihazards**

**Emergency Power Generators:** Upgrade all generators as needed.

**Upgrade social media outreach and education:** Establish a comprehensive social media presence to better communicate emergency alerts and updates to residents.

## Climate

The team chose to identify each mitigation measure by its hazard rather than creating a new category for climate considerations. This recognizes that climate is projected to affect nearly every category of natural hazard. The mitigation measures chosen by the local team took into account projections for increased flooding, drought, heat, and extreme weather.

### INTRODUCTION TO POTENTIAL MITIGATION MEASURES TABLE

Description of the Mitigation Measure – The description of each mitigation measure is brief and cost information is given only if cost data were already available from the community. The cost data represent a point in time and would need to be adjusted for inflation and for any changes or refinements in the design of a particular mitigation measure.

Priority – As described above and summarized in Table 38, the designation of high, medium, or low priority was done considering potential benefits and estimated project costs, as well as other factors in the STAPLEE (Social, Technical, Administrative, Legal, Economic, and Environmental) analysis.

Implementation Responsibility – The designation of implementation responsibility was done based on a general knowledge of what each municipal department is responsible for. It is likely that most mitigation measures will require that several departments work together and assigning staff is the sole responsibility of the governing body of each community.

Time Frame – The time frame was based on a combination of the priority for that measure, the complexity of the measure and whether or not the measure is conceptual, in design, or already designed and awaiting funding. Because the time frame for this plan is five years, the timing for all mitigation measures has been kept within this framework. The identification of a likely time frame is not meant to constrain a community from taking advantage of funding opportunities as they arise.

Potential Funding Sources – This column attempts to identify the most likely sources of funding for a specific measure. The information on potential funding sources in this table is preliminary and varies depending on a number of factors. These factors include whether or not a mitigation measure has been studied, evaluated or designed, or if it is still in the conceptual stages. MEMA and DCR assisted MAPC in reviewing the potential eligibility for hazard mitigation funding. Each grant program and agency has specific eligibility requirements that would need to be taken into consideration. In most instances, the measure will require a number of different funding sources. Identification of a potential funding source in this table does not guarantee that a project will be eligible for, or selected for funding. Upon adoption of this plan, the local team responsible for its implementation should begin to explore the funding sources in more detail.

Additional information on funding sources – The best way to determine eligibility for a particular funding source is to review the project with a staff person at the funding agency. The following websites provide an overview of programs and funding sources.

Army Corps of Engineers (ACOE) – The website for the North Atlantic district office is <http://www.nae.usace.army.mil/>. The ACOE provides assistance in a number of types of projects

including shoreline/streambank protection, flood damage reduction, flood plain management services and planning services.

Massachusetts Emergency Management Agency (MEMA) – The grants page

<https://www.mass.gov/hazard-mitigation-assistance-grant-programs> describes the various Hazard Mitigation Assistance Program.

**Table 39: Potential Hazard Mitigation Measures**

Mitigation Action	Priority	Lead Implementation	Time Frame	Estimated Cost	Potential Funding Source
<b>FLOOD (Inland, Coastal, Stormwater, Dams)</b>					
Complete upgrade of Great Pond Dam	Medium	DPW	2020	Medium	Capital
West Street / Pond Street Roadway Flooding Elevation Assessment	Low	DPW	2023	High	Capital
Repetitive Loss Area Property Owner Outreach	High	Planning	On-going	Low	Department Operating Budget
Relocate Braintree Highway Department Barn	High	DPW	2021	High	FEMA grant, capital
Enhance Drainage at Union Street and Route 3	High	DPW	2020	High	State funds
Promote Low Impact Development Techniques and Encourage Reduction of Impervious Pavement	Medium	Conservation Commission, Planning Board, Stormwater Division	On-going	Low	Town funds
Continue Participation in CRS Program	Medium	Planning	On-going	Low	Department Operating Budget
Map Storm Drain System	High	DPW	2020	High	Stormwater Utility
Restore Riverfront and Floodplain to Natural Conditions	High	Planning	On-going	High	Redevelopment mitigation (or CPA funds for public land)
Continue Public Education on Flood Mitigation	High	Planning SW Utility	On-going	Low	Department Operating Budget
Continue to enforce the Floodplain Zoning District Requirements	High	Planning	On-going	Low	Department Operating Budget
Acquire Vacant Flood Prone Lands	Medium	Planning	On-going	High	CPA funds

Mitigation Action	Priority	Lead Implementation	Time Frame	Estimated Cost	Potential Funding Source
Update Rainfall Rates in Stormwater and Wetlands Bylaws	High	DPW, Conservation Commission	2020	Low	Department Operating Budget
<b>BRUSHFIRE</b>					
Acquire Brushfire Truck	High	Fire	2020	High	Capital
<b>WIND (Hurricanes, Tornados, Nor'easters, Severe Thunderstorms)</b>					
Replace Elementary School Roofs with Wind Resistant Materials	High	Facilities, Schools	2023	High	Capital
<b>DROUGHT</b>					
Develop Opportunities for Additional Surface Water Storage	High	DPW, Tri-town Water Board	2023	High	Capital, Tri-town Board of Water Commissioners
<b>EARTHQUAKE</b>					
Municipal building assessment	Low	Building	2023	Low	Capital
<b>LANDSLIDE</b>					
Identify areas of potential landslide risk	Low	DPW	2023	Low	Department Operating Budget
<b>EXTREME HEAT AND COLD</b>					
Investigate opportunities to increase availability of battery storage.	Medium	BELD	2023	High	Grants
Upgrade Doherty Gym shelter	High	Facilities	2021	High	Capital, CPA
<b>WINTER</b>					
Purchase sidewalk plows	High	DPW	2020	High	Capital
Do public outreach and education on frozen pipe risk	Medium	Building	On-going	Low	Department Operating Budget
<b>MULTIHAZARD</b>					
Upgrade generators	High	Facilities, BELD	On-going	High	Capital
Upgrade social media outreach and education	Medium	Mayor's Office	On-going	Low	Department Operating Budget



# SECTION 9: PLAN ADOPTION & MAINTENANCE

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## PLAN ADOPTION

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The Braintree Hazard Mitigation Plan 2019 Update was adopted by the Town Council on July 16, 2019. See Appendix D for documentation. The plan was approved by FEMA on [ADD DATE] for a five-year period that will expire on [ADD DATE].

---

## PLAN MAINTENANCE

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MAPC worked with the Braintree Hazard Mitigation Planning Team to prepare this plan. After approval of the plan by FEMA, this group will meet to function as the Hazard Mitigation Implementation Team, with the LEPC and CRS Coordinators jointly designated as coordinators. Additional members could be added to the local implementation team from businesses, non-profits and institutions. The Town will encourage public participation during the next 5-year planning cycle. As annual updates and a review of the plan are conducted by the Hazard Mitigation Implementation Team, these will be placed on the Town's web site, and any meetings of the Hazard Mitigation Implementation Team will be publicly noticed in accordance with town and state open meeting laws.

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## IMPLEMENTATION AND EVALUATION SCHEDULE

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Annual Review – The coordinator of the Hazard Mitigation Implementation Team will convene the team annually to consider changes or revisions to the plan that may be needed, progress and accomplishments, and any new hazards or problem areas that have been identified.

This information will be used to prepare a report or addendum to the local hazard mitigation plan in order to evaluate its effectiveness in meeting the plan's goals and identify areas that need to be updated in the next plan. The Hazard Mitigation Implementation Team, coordinated by the CRS and LEPC Coordinators, will have primary responsibility for tracking progress, evaluating, and updating the plan.

Begin to Prepare for the next Plan Update – FEMA's approval of this plan is valid for five years, by which time an updated plan must be approved by FEMA in order to maintain the town's approved plan status and its eligibility for FEMA mitigation grants. Given the lead time needed to secure funding and conduct the planning process, the Hazard Mitigation Implementation Team will begin to prepare for an update of the plan in year three. This will help the Town avoid a lapse in its approved plan status and grant eligibility when the current plan expires.

The Hazard Mitigation Implementation Team will use the information from the annual review to identify the needs and priorities for the plan update and seek funding for the plan update process. Potential sources of funding may include FEMA Pre-Disaster Mitigation grants and the Hazard Mitigation Grant Program. Both grant programs can pay for 75% of a planning project, with a 25% local cost share required.

Prepare and Adopt an Updated Local Hazard Mitigation Plan – Once the resources have been secured to update the plan, the Hazard Mitigation Implementation Team may decide to undertake the update themselves, contract with the Metropolitan Area Planning Council to update the plan or to hire another consultant. However the Hazard Mitigation Implementation Team decides to update the plan, the group will need to review the current FEMA hazard mitigation plan guidelines for any changes. The Braintree

Hazard Mitigation Plan Update will be forwarded to MEMA and DCR for review and to FEMA for approval.

---

## **INTEGRATION OF THE PLANS WITH OTHER PLANNING INITIATIVES**

---

Upon approval of the Braintree Hazard Mitigation Plan 2019 Update by FEMA, the Local Hazard Mitigation Team will provide all interested parties and implementing departments with a copy of the plan and will initiate a discussion regarding how the plan can be integrated into that department's ongoing work. At a minimum, the plan will be reviewed and discussed with the following departments:

- Fire/Emergency Management
- Police
- Public Works
- Planning
- Light Department
- Building Department
- Tri-town Water Board

Other groups that will be coordinated with include large institutions, Chambers of Commerce, land conservation organizations and watershed groups. The plan will also be posted on the Town's website with the caveat that a local team coordinator will review the plan for sensitive information that would be inappropriate for public posting. The posting of the plan on the website will include a mechanism for citizen feedback such as an e-mail address to send comments.

The Hazard Mitigation Plan will be integrated into other town plans and policies as they are updated and renewed, including the Open Space and Recreation Plan, Comprehensive Emergency Management Plan, Master Plan, and Capital Plan.

## SECTION 10: LIST OF REFERENCES

Town of Braintree, Massachusetts, <http://www.Braintreema.gov/>

Town of Braintree, Massachusetts. *Zoning Bylaws*

Town of Braintree, draft Open Space and Recreation Plan

FEMA, Flood Insurance Rate Maps for Norfolk County, MA, 2012

FEMA, Local Mitigation Plan Review Guide; October 1, 2011

MA Emergency Management Agency, *State Hazard Mitigation Plan*, 2013

MA Emergency Management Agency, *State Hazard Mitigation and Climate Adaptation Plan*, 2018

MA Geographic Information System, *McConnell Land Use Statistics*, 2005

MA Office of Dam Safety, *Inventory of Massachusetts Dams*

Metropolitan Area Planning Council, Geographic Information Systems Lab

New England Seismic Network, Weston Observatory, <http://aki.bc.edu/index.htm>

Northeast States Emergency Consortium, website <http://www.nesec.org/>

NOAA, National Climatic Data Center, website

U. S. Census, 2010, and American Community Survey, 2013

USGS, National Water Information Center, website

# APPENDIX A: MEETING AGENDAS

# **Braintree Hazard Mitigation Plan Update**

## **LOCAL HAZARD MITIGATION PLANNING TEAM**

### **Meeting #1**

Thursday, October 25, 2018

Braintree Town Hall

## **AGENDA**

1. Welcome and Introductions
2. Overview of the Planning Process
3. Identify/update local hazard areas
  - a) Flood Hazard Areas
  - b) Fire Hazard Areas (brushfires/ wildfires)
  - c) Other hazards
4. Identify and Map Potential New Development Sites
5. Review Critical Infrastructure
6. Update Hazard Mitigation Goals
7. Next Meeting

# Braintree Hazard Mitigation Plan 2019 Update

Wednesday, December 5, 2018

10:00 -11:30

Meeting #2

## AGENDA

1. Introductions
2. Review original existing mitigation measures from the 2005 plan
  - confirm effectiveness
  - note any needed changes
3. Review recommended mitigation measures from 2012 plan
  - current status
  - decide which to carry forward into 2019 plan
4. Schedule first public meeting and third team meeting

# AGENDA

## Braintree Local Hazard Mitigation Planning Team Meeting #3

Wednesday, January 23  
10:00 am – 11:30 am

---

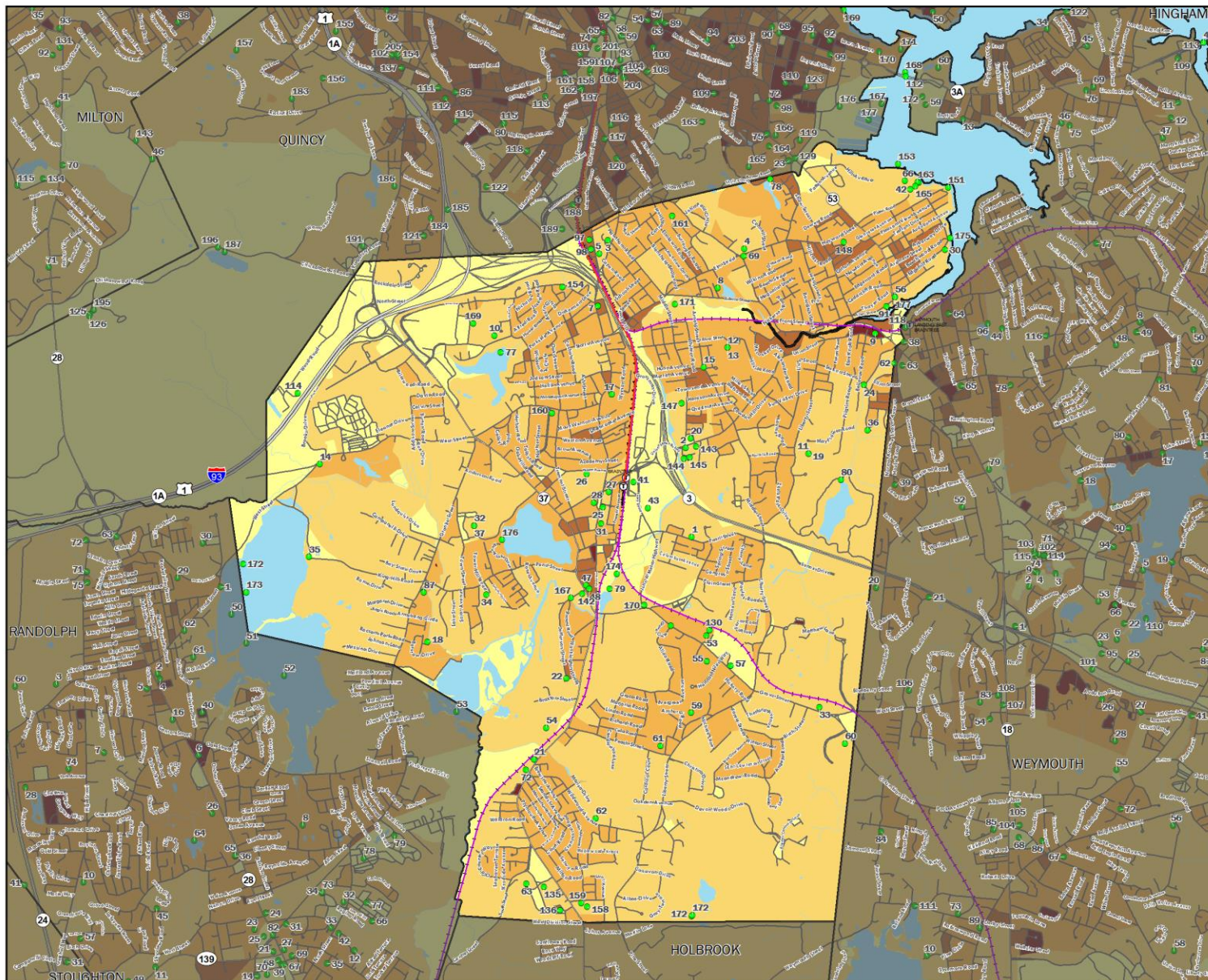
### PROPOSE NEW MITIGATION MEASURES FOR THE 2019 PLAN

Review carried over items  
Consider new items

### NEXT STEPS

Complete Plan  
Schedule final public meeting

# APPENDIX B: HAZARD MAPPING

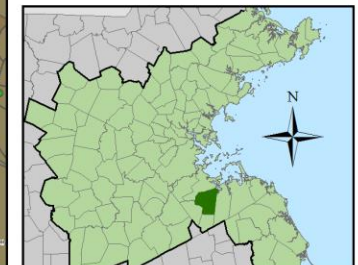


FEMA Hazard  
Mitigation Planning Grant  
**BRAINTREE, MA**

Map 1: Population Density

- Sites**
- Critical Infrastructure Sites\*
  - Ⓣ Train Stations
- \* See details in separate table
- Water Bodies**
- All Roads**
- Interstate
  - U.S. Highway
  - State Route
  - Street
- Population Density  
2010 Census Blocks  
People Per Acre**
- 0 or No Data
  - 0.1 - 5.0
  - 5.1 - 15.0
  - 15.1 - 30.0
  - More than 30

0 0.25 0.5 Miles

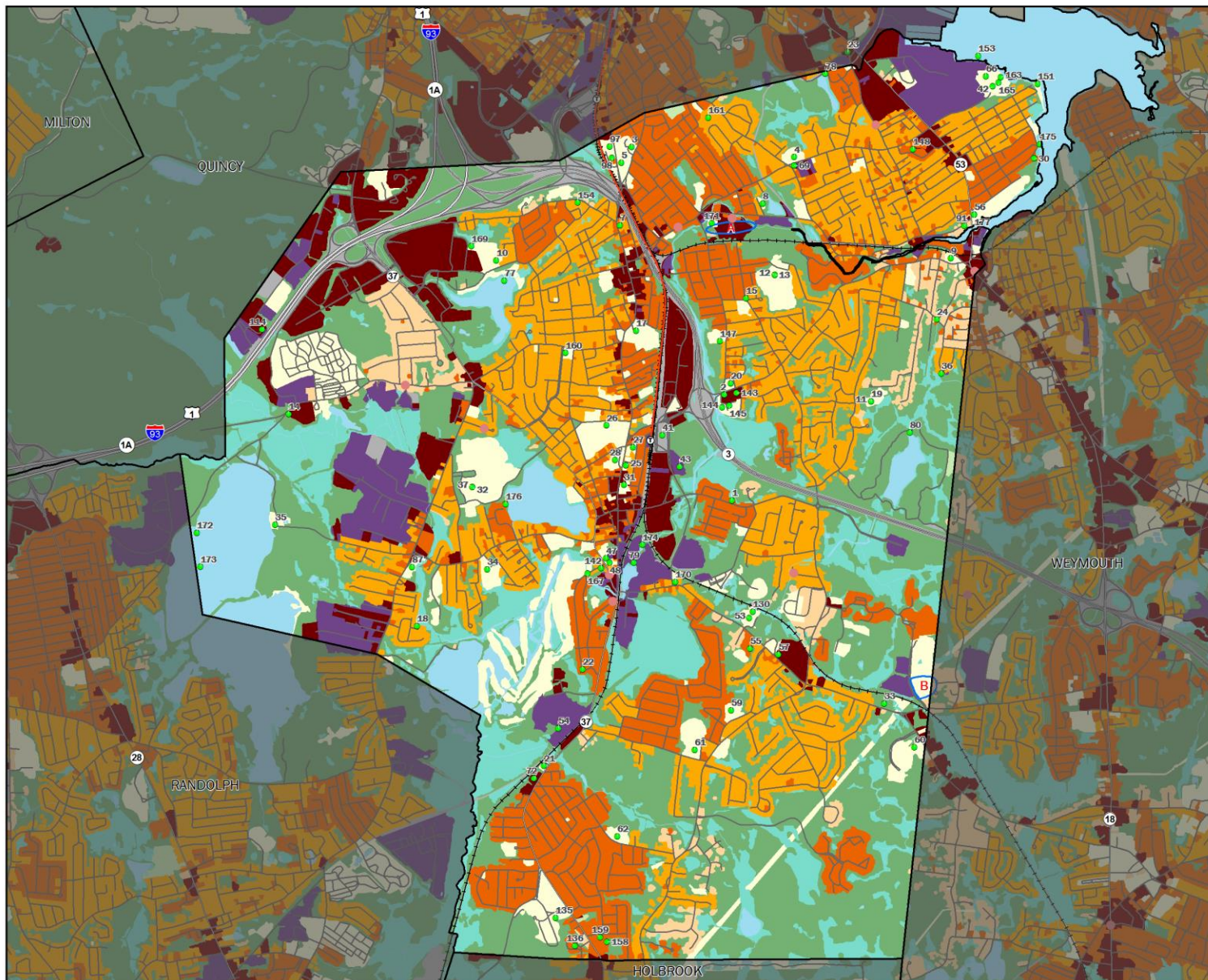


The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.

Produced by MAPC Data Services  
60 Temple Place, Boston, MA 02111 (617) 451-2770

**Data Sources:**  
Metropolitan Area Planning Council (MAPC)  
Massachusetts Geographic Information System (MassGIS)  
Northeast States Emergency Consortium (NESEC)  
Massachusetts Emergency Management Agency (MEMA)  
Federal Emergency Management Agency (FEMA)  
.MA

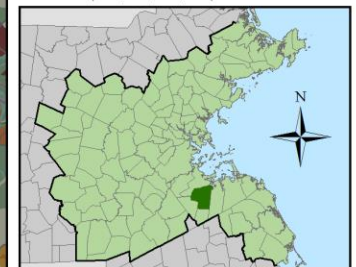
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Date: 12/13/2018



FEMA Hazard  
Mitigation Planning Grant  
**BRAINTREE, MA**  
Map 2: Land Use

- Sites**
- Critical Infrastructure Sites\*
  - Repetitive Loss Sites
  - \* See details in separate table
- Development Areas**
- See details in separate table
- Land Use (2005)**
- High Density Residential
  - Medium Density Residential
  - Low Density Residential
  - Non-Residential Developed
  - Commercial
  - Industrial
  - Transportation
  - Agriculture
  - Undeveloped
  - Undeveloped Wetlands
- Train Stations**
- Train Stations
  - Commuter Rail Lines
  - Trains
- All Roads**
- Interstate
  - U.S. Highway
  - State Route
  - Street
  - Water Bodies

0 0.25 0.5 Miles

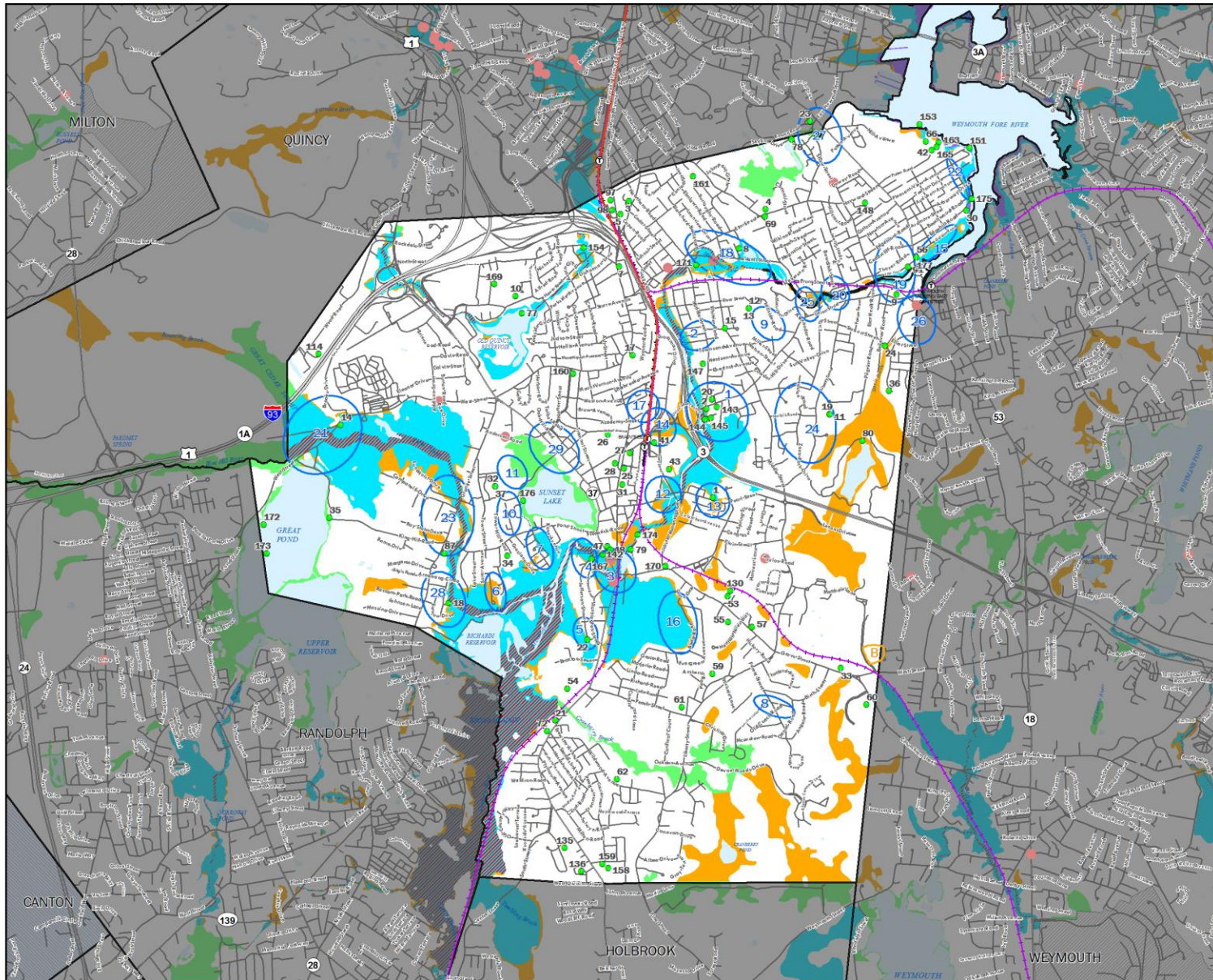


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**Data Sources:**  
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Massachusetts Geographic Information System (MassGIS)  
Northeast States Emergency Consortium (NESEC)  
Massachusetts Emergency Management Agency (MEMA)  
Federal Emergency Management Agency (FEMA)  
BRAINTREE, MA

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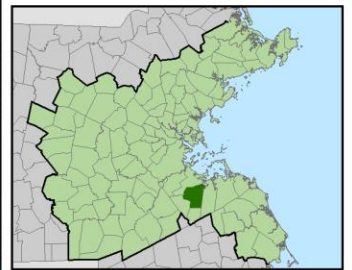


MAPC   dcr

FEMA Hazard  
Mitigation Planning Grant  
**BRAINTREE, MA**  
Map 3: Flood Zones

- Sites**
- Critical Infrastructure Sites\*
  - Repetitive Loss Sites
- \* See details in separate table
- Flood Zones, 2017**
- (Annual Chance)**
- A: 1% Annual Chance of Flooding.
  - AE: 1% Annual Chance of Flooding.
  - AE: Regulatory
  - AO: 1% Annual Chance of 1-3ft Sheet Flow Flooding.
  - VE: High Risk
  - X: 0.2% Annual
  - Area Not Included
  - Area with no DFIRM - Paper FIRMs in
- Locally Identified Hazard Areas\***
- Flooding
  - Development Areas\*
- \* See details in separate table
- Infrastructure**
- Train Stations
  - Commuter Rail Lines
  - Trains
- All Roads**
- Interstate
  - U.S. Highway
  - State Route
  - Street
- Water Bodies**
- Water Bodies

0 0.25 0.5 Miles



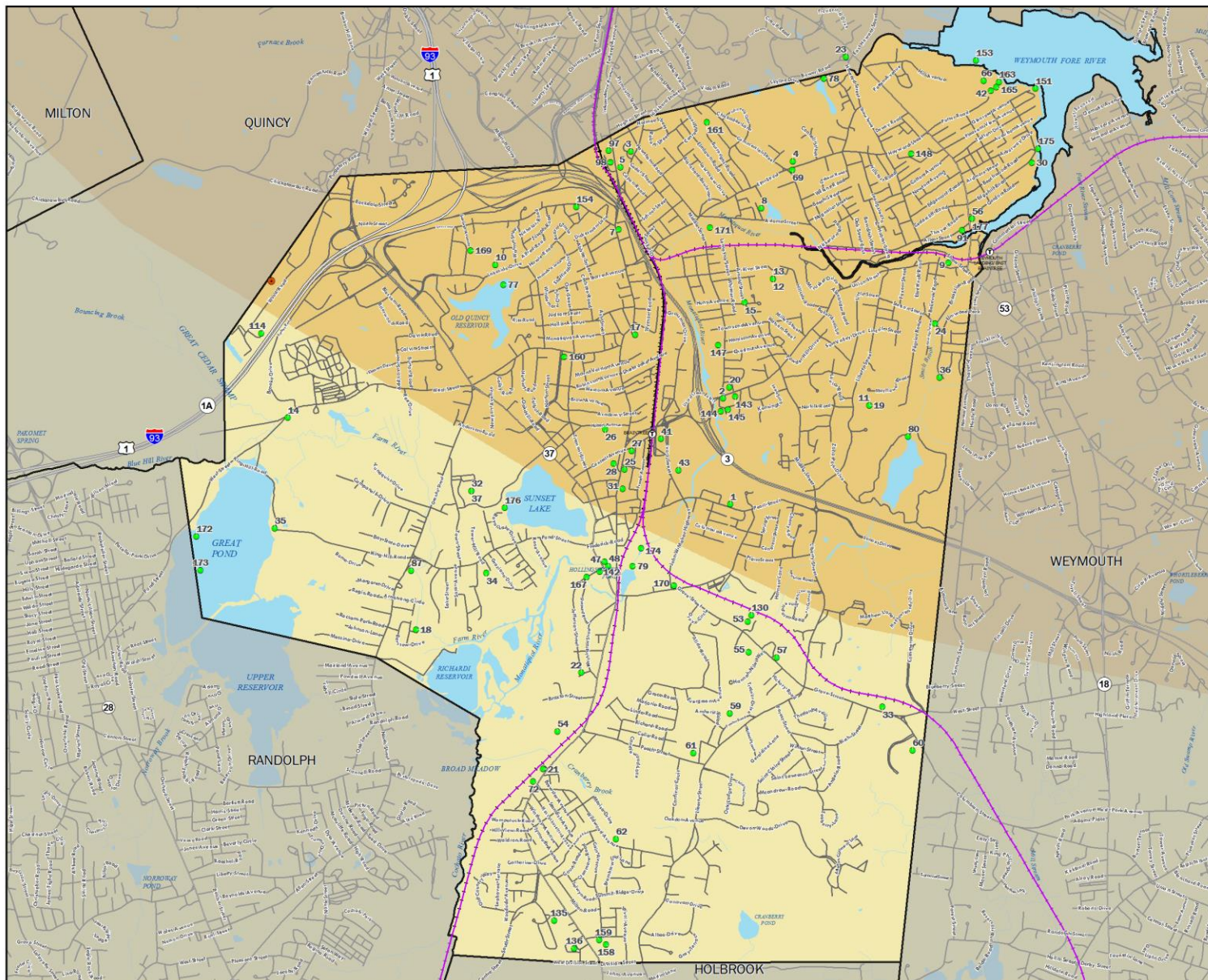
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.

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60 Temple Place, Boston, MA 02111 (617) 451-2770

Data Sources:  
Metropolitan Area Planning Council (MAPC)  
Massachusetts Geographic Information System (MassGIS)

Flood Zones datalayer updated by MassGIS October 2013  
from finalized data provided by  
Federal Emergency Management Agency (FEMA)

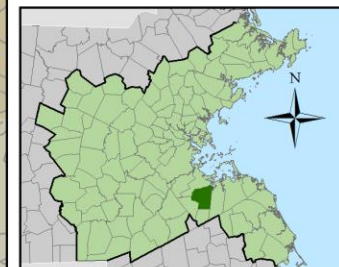
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Date: 12/13/2018



FEMA Hazard  
Mitigation Planning Grant  
**BRAINTREE, MA**

Map 4: Earthquakes / Landslides

- Sites**
- Critical Infrastructure Sites\*
  - Water Bodies
- \* See details in separate table
- Earthquakes**
- Epicenters
  - Train Stations
  - Commuter Rail Lines
  - Trains
- All Roads**
- Interstate
  - U.S. Highway
  - State Route
  - Street
- Landslides**
- High landslide incidence (greater than 15% of the area is involved in landsliding)
  - High susceptibility to landsliding and moderate incidence
  - High susceptibility to landsliding and low incidence
  - Moderate susceptibility to landsliding and low incidence
  - Low landslide incidence (less than 1.5 % of the area is involved in landsliding)
- 0 0.25 0.5 Miles

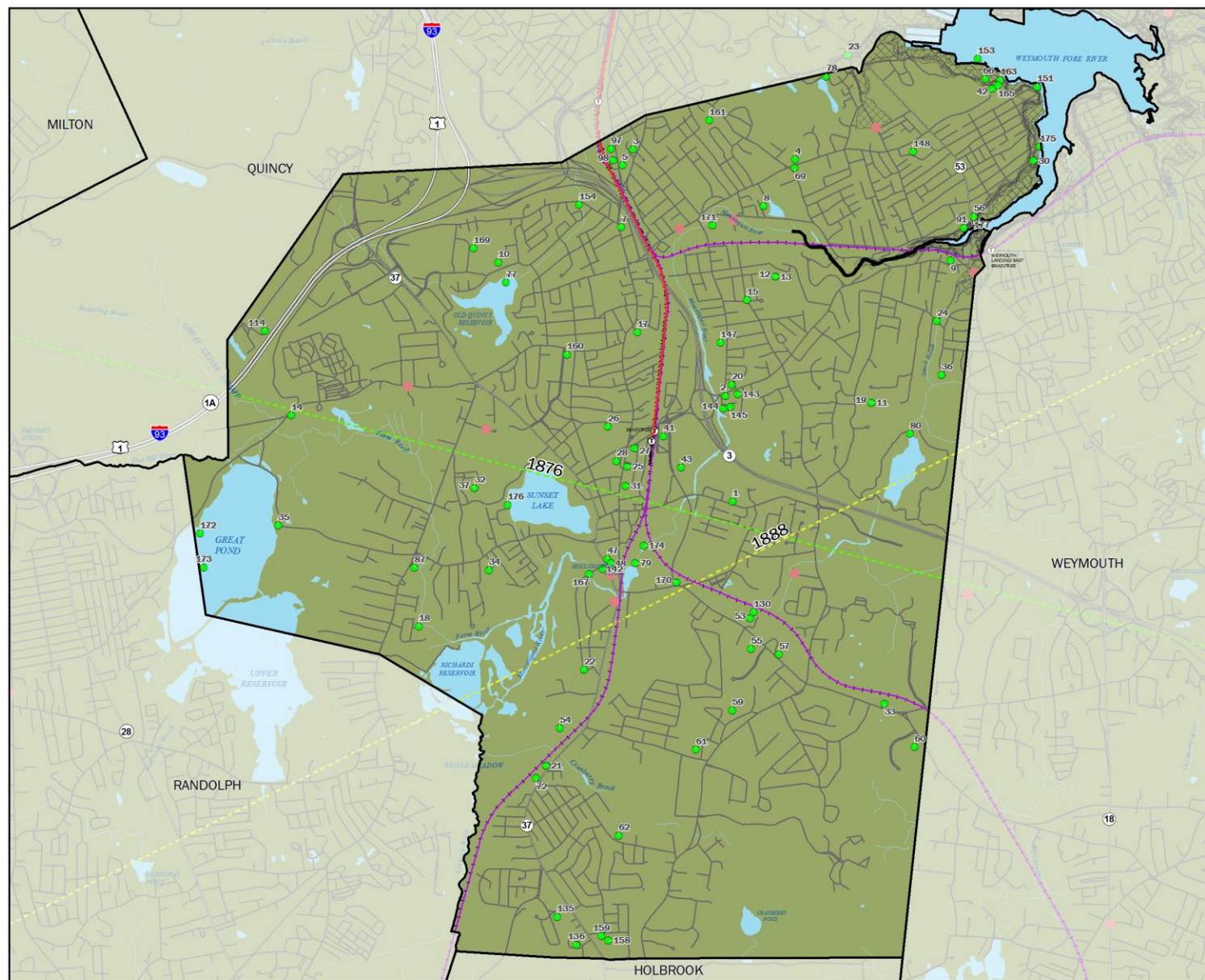


The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.

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**Data Sources:**  
Metropolitan Area Planning Council (MAPC)  
Massachusetts Geographic Information System (MassGIS)  
Northeast States Emergency Consortium (NESEC)  
Massachusetts Emergency Management Agency (MEMA)  
Federal Emergency Management Agency (FEMA)  
BRAINTREE, MA

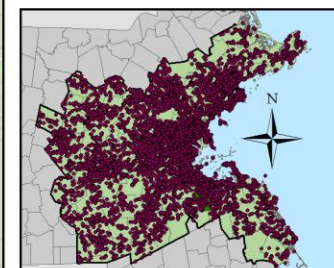
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Date: 12/13/2018



FEMA Hazard  
Mitigation Planning Grant  
**BRAINTREE, MA**  
Map 5: Hurricanes / Tornadoes

- Sites**
- Critical Infrastructure Sites\*
  - Repetitive Loss Sites
  - \* See details in separate table
- Tornadoes**
- ▼ Tornado
- Storm Tracks**
- Tropical Depression
  - Tropical Storm
  - Category 1 Hurricane
  - Category 2 Hurricane
  - Category 3 Hurricane
  - Year of storm noted on map
  - ☐ Hurricane Surge Inundation Areas
  - Train Stations
  - Commuter Rail Lines
  - Trains
- All Roads**
- Interstate
  - U.S. Highway
  - State Route
  - Street
  - Water Bodies
- 100 Year Wind Speeds**
- Miles Per Hour**
- 90 MPH
  - 100 MPH
  - 110 MPH
  - 120 MPH
  - 130 MPH

0 0.25 0.5 Miles



The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.

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**Data Sources:**  
Metropolitan Area Planning Council (MAPC)  
Massachusetts Geographic Information System (MassGIS)  
Northeast States Emergency Consortium (NESEC)  
Massachusetts Emergency Management Agency (MEMA)  
Federal Emergency Management Agency (FEMA)

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Date: 12/13/2018

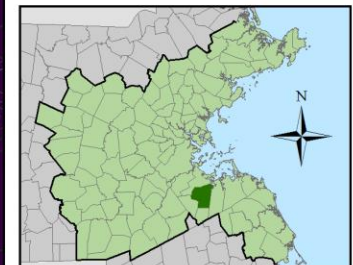


FEMA Hazard  
Mitigation Planning Grant  
**BRAINTREE, MA**

Map 6: Average Snowfall

- Sites**  
● Critical Infrastructure Sites\*
- Average Annual Snowfall**  
36.1 to 48.0 inches  
48.1 to 72.0 inches
- Water Bodies**  
Water Bodies
- Train Stations**  
Commuter Rail Lines  
Trains
- All Roads**  
Interstate  
U.S. Highway  
State Route  
Street

0 0.25 0.5 Miles

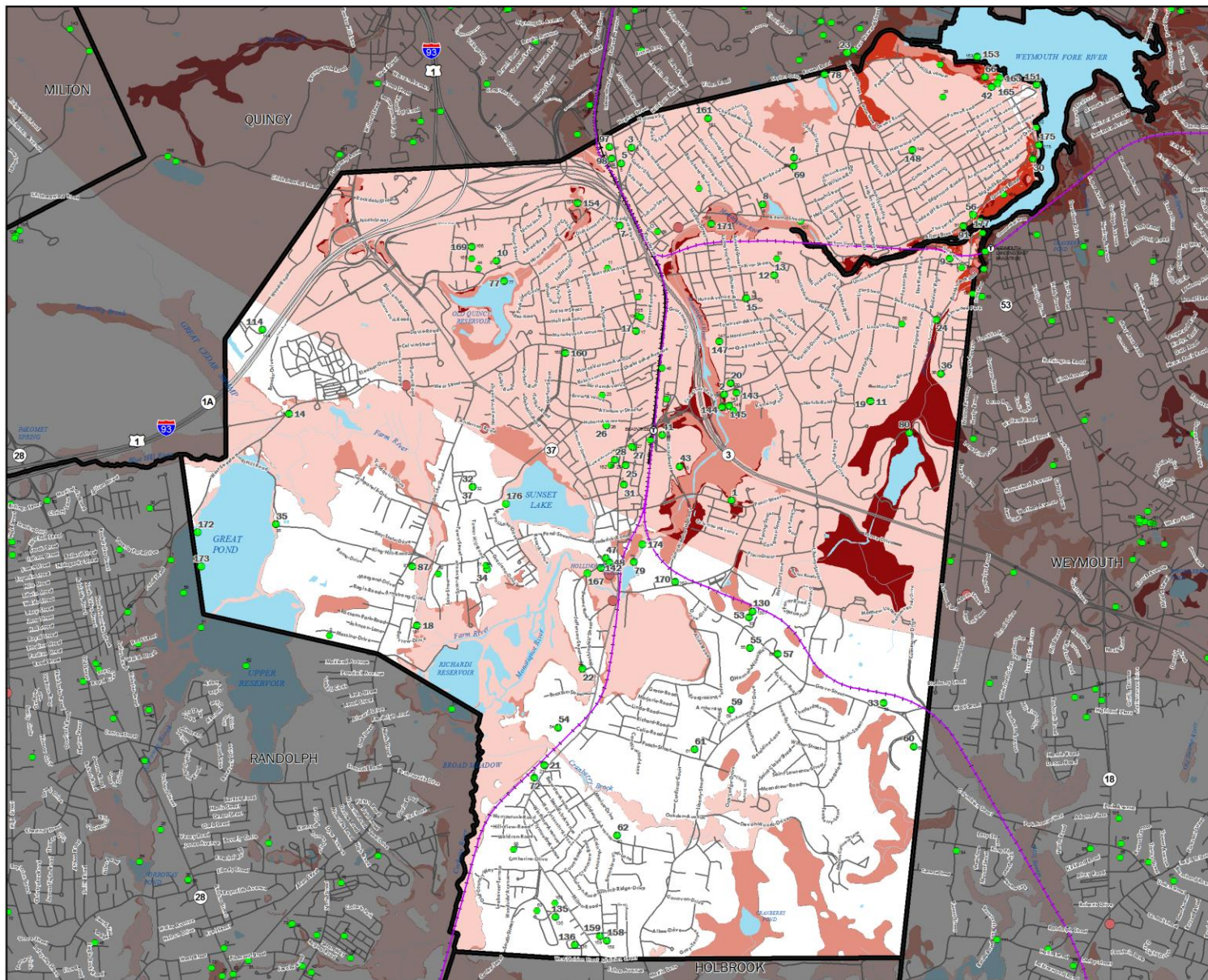


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60 Temple Place, Boston, MA 02111 (617) 451-2770

Data Sources:  
Metropolitan Area Planning Council (MAPC)  
Massachusetts Geographic Information System (MassGIS)  
Northeast States Emergency Consortium (NESEC)  
Massachusetts Emergency Management Agency (MEMA)  
Federal Emergency Management Agency (FEMA)  
BRAINTREE, MA

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Date: 12/13/2018



# FEMA Hazard Mitigation Planning Grant **BRAINTREE, MA**

Map 7: Composite Natural Hazards

## Composite Natural Hazards

- Low (2 Hazards)
- Moderate (3 Hazards)
- High (4 Hazards)
- Very High (5 Hazards)

Composite natural hazards shown for areas of existing development. Hazards include:

- 100 year wind speed of 110 MPH or higher
- Moderate landslide risk
- FEMA flood zones (100 year and 500 year)
- Average snowfall of 36.1" or more
- Hurricane surge inundation areas

## Sites

- Critical Infrastructure Sites\*
- Repetitive Loss Sites

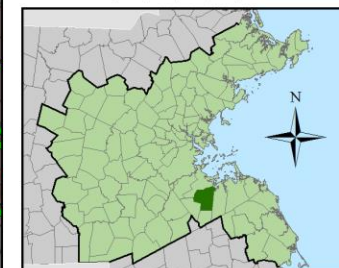
\* See details in separate table

Water Bodies

## All Roads

- Interstate
- U.S. Highway
- State Route
- Street
- Train Stations
- Commuter Rail Lines
- Trains

0 0.25 0.5 Miles



The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analysis.

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60 Temple Place, Boston, MA 02111 (617) 451-2770

## Data Sources

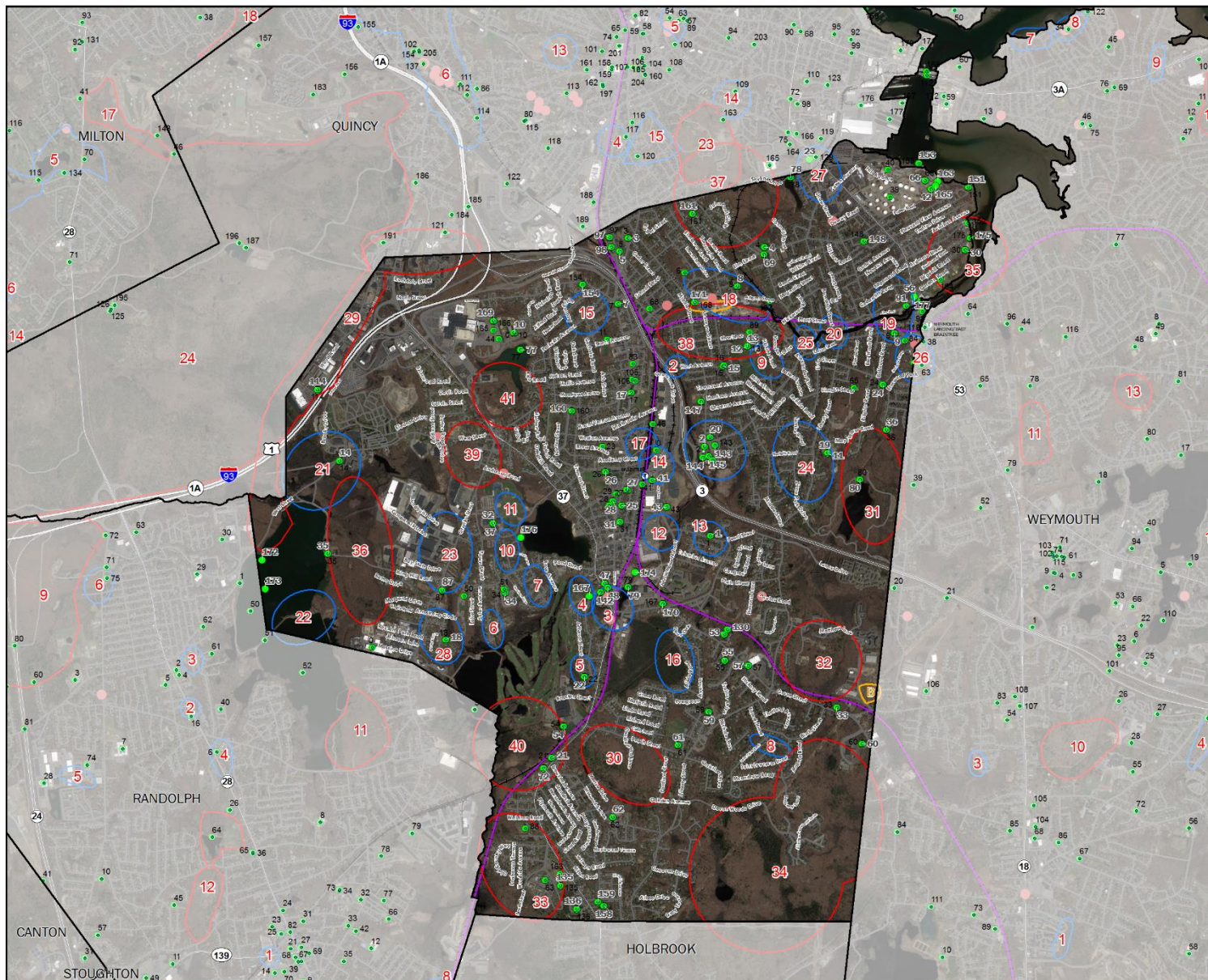
Composite Natural Hazard:  
Wind, Landslide Risk, Snow - Northeast States Emergency Consortium (NESEC)  
Flood Zones - 2013 FEMA/MassGIS  
Hurricane Surge - 2013 U.S. Army Corps of Engineers, New England District

Roads/Trains: MassDOT/ CTPS

Repetitive Loss Sites: DCR/Office of Flood Hazard Management

Critical Infrastructure: Metropolitan Area Planning Council (MAPC) / BRAINTREE, MA

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Date: 12/13/2018

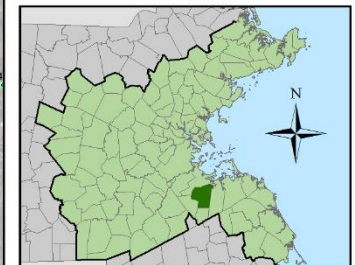


# FEMA Hazard Mitigation Planning Grant **BRAINTREE, MA**

Map 8: Local Hazard Areas

- Sites**
  - Critical Infrastructure Sites\*
  - Repetitive Loss Sites
  - \* See details in separate table
- Locally Identified Hazard Areas**
  - Brush Fires
  - Flooding
  - Historic
  - Development Sites
  - \* See details in separate table
- All Roads**
  - Interstate
  - U.S. Highway
  - State Route
  - Street
- Train Stations**
  - Commuter Rail Lines
  - Trains

0 0.5 1 Miles



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60 Temple Place, Boston, MA 02111 (617) 451-2770

**Data Sources**  
Metropolitan Area Planning Council (MAPC)  
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Northeast States Emergency Consortium (NESEC)  
Massachusetts Emergency Management Agency (MEMA)  
Federal Emergency Management Agency (FEMA)  
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BRAINTREE, MA

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Date: 12/13/2018

# APPENDIX C: PUBLIC MEETINGS

## CALENDAR LISTING / MEDIA ADVISORY

### BRAINTREE'S DRAFT HAZARD MITIGATION PLAN TO BE PRESENTED AT JANUARY 10 PUBLIC MEETING

*Meeting to present the 2019 update of Braintree's Hazard Mitigation Plan and solicit public comments*

**Who:** Braintree residents, business owners, representatives of non-profit organizations and institutions, and others who are interested in preventing and reducing damage from natural hazards.

**What:** At the Braintree Conservation Commission meeting on Thursday, January 10 at 7:00 PM, a presentation will be made by the Metropolitan Area Planning Council (MAPC), which is assisting the Town on the 2019 update of its Hazard Mitigation Plan.

The Town of Braintree adopted its first Hazard Mitigation Plan in 2005, which was approved by the Federal Emergency Management Agency (FEMA). This plan will update the 2012 plan. The plan identifies natural hazards affecting Braintree such as floods, hurricanes, winter storms, and earthquakes, as well as actions that the Town can take to reduce its vulnerability to these hazards.

**When:** Thursday, January 10 at 7:00 PM

**Where:** Braintree Town Hall  
1 JFK Memorial Drive  
Johnson Chambers

MAPC is the regional planning agency for 101 communities in the metropolitan Boston area, promoting smart growth and regional collaboration. More information about MAPC is available at [www.mapc.org](http://www.mapc.org).

##

# HAZARD MITIGATION PLAN PUBLIC MEETING

Natural hazards can have serious impacts on the Town of Braintree and its residents



The Braintree Hazard Mitigation Plan is being updated to help the town reduce its vulnerability to natural hazard events such as flooding, hurricanes and winter storms. Please join the Town for a public presentation and discussion about the update to the Braintree Hazard Mitigation Plan at a public meeting of the Conservation Commission:

**Date:** Thursday, January 10, 2019  
**Time:** 7:00 PM  
**Location:** Braintree Town Hall, Johnson Chambers  
1 JFK Memorial Drive, Braintree, MA

For more information, please contact Anne Herbst via phone at (617) 933-0781 or email [aherbst@mapc.org](mailto:aherbst@mapc.org)





Mayor Joseph C. Sullivan

## Department of Planning and Community Development

1 JFK Memorial Dr.  
Braintree, MA 02184  
781 794-8230

### Braintree Conservation Commission

Heather Charles Lis, Chair  
Donald Murphy, Vice-Chair  
Alan Weinberg, Clerk  
Joyce Albrecht  
Diane Francis  
Christopher Hayward  
Gail Poliner-Feldman

Staff: Kelly Phelan

## CONSERVATION COMMISSION AGENDA JANUARY 10, 2019 MEETING 7PM TOWN HALL- JOHNSON CHAMBERS

### PUBLIC HEARINGS

Notice of Intent DEP File #8-675 1577 Liberty St./Cox  
Request for Determination of Applicability 50 Thetford St./Shakr  
Request to Amend Order of Conditions DEP File # 8-673 1177 Washington St./Le

### OTHER BUSINESS

Presentation on the Hazard Mitigation Plan Update  
Request for Certificate of Compliance – DEP File #8-625 Cattle Pass Bridge/MWRA  
Request for Certificate of Compliance – DEP File #6-624 Adams St. Crossing/MWRA  
Request for Certificate of Compliance – DEP File #8- 645 385 Quincy Ave./CITGO  
Update Wetland Rules and Regulations  
Other  
Approval of Minutes – October 4, 2018  
December 6, 2018

Next Meeting: Thursday, February 7, 2019

Reasonable accommodations will be provided for persons with disabilities. To request accommodations, please call Braintree's ADA Coordinator at 781 794-8327 at least seven business days in advance. Arrangements will be provided at no cost.

## CALENDAR LISTING / MEDIA ADVISORY

### BRAINTREE'S DRAFT HAZARD MITIGATION PLAN TO BE PRESENTED AT APRIL 2 PUBLIC MEETING

*Meeting to present the 2019 update of Braintree's Hazard Mitigation Plan and solicit public comments*

**Who:** Braintree residents, business owners, representatives of non-profit organizations and institutions, and others who are interested in preventing and reducing damage from natural hazards.

**What:** At the Braintree Town Council meeting on Tuesday, April 2, at 7:30 PM, a presentation will be made by the Metropolitan Area Planning Council (MAPC), which is assisting the Town on the 2019 update of its Hazard Mitigation Plan.

The Town of Braintree adopted its first Hazard Mitigation Plan in 2005, which was approved by the Federal Emergency Management Agency (FEMA). This plan will update the 2012 plan. The plan identifies natural hazards affecting Braintree such as floods, hurricanes, winter storms, and earthquakes, as well as actions that the Town can take to reduce its vulnerability to these hazards.

**When:** Tuesday, April 2, at 7:30 PM

**Where:** Braintree Town Hall  
1 JFK Drive  
Horace T. Cahill Auditorium

MAPC is the regional planning agency for 101 communities in the metropolitan Boston area, promoting smart growth and regional collaboration. More information about MAPC is available at [www.mapc.org](http://www.mapc.org).

##

# HAZARD MITIGATION PLAN PUBLIC MEETING

Natural hazards can have serious impacts on the Town of Braintree and its residents



The Braintree Hazard Mitigation Plan is being updated to help the town reduce its vulnerability to natural hazard events such as flooding, hurricanes and winter storms.

*Join the town's Hazard Mitigation Team for a presentation and discussion about the draft 2019 update to the Braintree Hazard Mitigation Plan at a public meeting of the Braintree Town Council:*

**Date:** Tuesday, April 2, 2019

**Time:** 7:30 PM

**Location:** Horace T. Cahill Auditorium, Braintree Town Hall  
1 JFK Drive, Braintree, MA

For more information, please contact Anne Herbst via phone at (617) 933-0781 or email [aherbst@mapc.org](mailto:aherbst@mapc.org)



Charles B. Ryan  
President  
At Large

Shannon L. Hume  
At Large

Sean E. Powers  
At Large

Thomas W. Whalen  
District 2

Thomas M. Bowes  
District 3



Charles C. Kokoros  
Vice President  
District 1

Stephen C. O'Brien  
District 4

David M. Ringius, Jr.  
District 5

Timothy P. Carey  
District 6

## OFFICE OF THE TOWN COUNCIL

### – AGENDA –

**Tuesday, APRIL 2, 2019** • Horace T. Cahill Auditorium, Town Hall • Starting Time: **7:30PM**

#### PLEDGE OF ALLEGIANCE/MOMENT OF SILENCE

#### ANNOUNCEMENTS

#### APPROVAL OF MINUTES

- February 26, 2019
- March 5, 2019

#### COMMUNICATIONS

- 012 19 Mayor/Council President: Zoning Working Group
- 013 19 Chief Shastany: Update - Police Evidence Room / Accreditation Process
- 014 19 Kelly Phelan: Presentation of the Draft Hazard Mitigation Plan

#### OLD BUSINESS

- 18 025 Mayor: Demolition Delay Ordinance or take up any action relative thereto (PUBLIC HEARING)
- 19 012 Superintendent of Schools: Statement of Interest (SOI) with the MSBA for Braintree High School or take up any action relative thereto

#### NEW BUSINESS

- None

#### RESOLUTIONS

- 015 19 Councilor Powers: Proposed Resolution - Update Master Plan

Topics the Chair does not reasonably anticipate will be discussed

#### UPCOMING MEETINGS:

Next Council Meeting will be held on: **TUESDAY, April 23, 2019@ 7:30pm**

#### ADJOURNMENT

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Town of Braintree, One JFK Memorial Drive, Braintree, Massachusetts 02184-6498  
Telephone: (781) 794-8152 Fax: (781) 794-8270 Email: [towncouncil@braintree.ma.gov](mailto:towncouncil@braintree.ma.gov)

# APPENDIX D: PLAN ADOPTION



Braintree Town Council

ORDER NO: 19 025

DATE FILED: APRIL 2, 2019

REQUEST OF: THE MAYOR

**UPON THE REQUEST OF HIS HONOR, THE MAYOR, THE TOWN OF BRAINTREE, THROUGH THE BRAINTREE TOWN COUNCIL, IT IS SO ORDERED:**

To Adopt the Hazardous Mitigation Plan 2019 Update.

YEAS: Bowes, Carey, Hume, Kokoros, O'Brien, Powers, Ryan, Whalen

NAYS: NONE

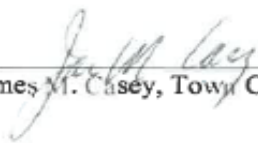
ABSENT: Ringius

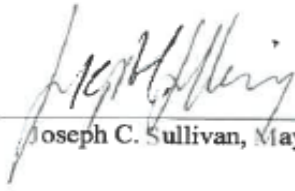
PASSED IN COUNCIL: JULY 16, 2019  
PRESENTED TO MAYOR: JULY 17, 2019

A True Record, Attest:

7/23/19

Date Approved

  
James M. Chasey, Town Clerk

  
Joseph C. Sullivan, Mayor

A True Copy Attest

  
Town Clerk

Charles B. Ryan  
President  
At Large

Shannon L. Hume  
At Large

Sean E. Powers  
At Large

Thomas W. Whalen  
District 2

Thomas M. Bowes  
District 3



Charles C. Kokoros  
Vice President  
District 1

Stephen C. O'Brien  
District 4

David M. Ringius, Jr.  
District 5

Timothy P. Carey  
District 6

## OFFICE OF THE TOWN COUNCIL

### CERTIFICATE OF ADOPTION TOWN COUNCIL

#### TOWN OF BRAINTREE, MASSACHUSETTS

#### A RESOLUTION ADOPTING THE TOWN OF BRAINTREE HAZARD MITIGATION PLAN 2019 UPDATE

WHEREAS, the Town of Braintree established a Committee to prepare the *Town of Braintree Hazard Mitigation Plan 2019 Update*; and

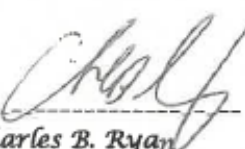
WHEREAS, the *Town of Braintree Hazard Mitigation Plan 2019 Update* contains several potential future projects to mitigate potential impacts from natural hazards in the Town of Braintree, and

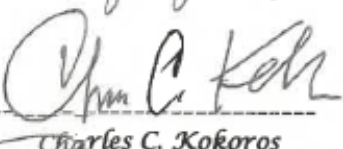
WHEREAS, duly-noticed public meetings were held by the LOCAL HAZARD MITIGATION PLANNING TEAM on January 10, 2019 and April 2, 2019 and


WHEREAS, the Town of Braintree authorizes responsible departments and/or agencies to execute their responsibilities demonstrated in the plan, and

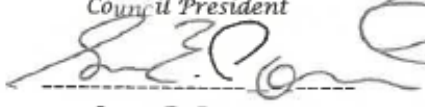
NOW, THEREFORE BE IT RESOLVED that the Town of Braintree TOWN COUNCIL adopts the *Town of Braintree Hazard Mitigation Plan 2019 Update*, in accordance with M.G.L. 40 §4 or the charter and bylaws of the Town of Braintree.

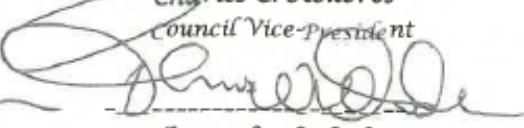
ADOPTED AND SIGNED this Date. July 16, 2019

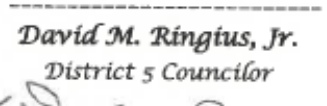
  
Charles B. Ryan  
Council President

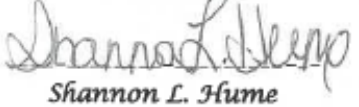
  
Charles C. Kokoros  
Council Vice-President

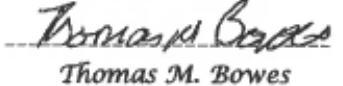
  
Stephen C. O'Brien  
District 4 Councilor

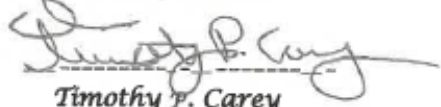
  
Sean E. Powers  
Councilor At-Large

  
Thomas W. Whalen  
District 2 Councilor

  
David M. Ringius, Jr.  
District 5 Councilor

  
Shannon L. Hume  
Councilor At-Large

  
Thomas M. Bowes  
District 3 Councilor

  
Timothy P. Carey  
District 6 Councilor